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ABSTRACT

Intended for the staffs of museums, zoos, and other science related centers, this manual is a step by step guide to establishing a rural science outreach and education program. Based on the experiences of the New Mexico Rural Science Education Project (NMRSEP), this manual focuses on rural elementary schools and on earth and life sciences. Much of its material, however, may be applicable to other educational levels and other areas of science. Chapters outline the following topics: (1) steps necessary to gain support from museum leadership; (2) ways to find funding; (3) program placement within the organization; (4) selection of appropriate project staff; (5) outreach strategies; (6) tips for establishing effective partnerships with rural schools and teachers; (7) identification and development of program content; and (8) evaluation of program effectiveness. Recommended program components include: (1) a review of state and district science goals and requirements; (2) field surveys of local natural resources in each school's community; (3) preparation of resource materials for teachers, based on the field surveys; (4) field trips and inservice workshops for teachers; (5) expansion of rural teachers' education network; and (6) ongoing support from the museum. Many examples and sample activities are provided. Appendices contain a history and description of NMRSEP and an annotated bibliography of over 70 resource materials. (SV)

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Strengthening Science Outreach Programs for Rural Elementary Schools:

A Manual for Museum Staffs

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Developed through

Strengthening Science in Rural, Small Schools

a joint project of
Southwest Educational Development Laboratory
New Mexico Museum of Natural History
New Mexico Center for Rural Education
Wesley A. Hoover, Project Director

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STRENGTHENING SCIENCE OUTREACH PROGRAMS FOR RURAL ELEMENTARY SCHOOLS: A MANUAL FOR MUSEUM STAFFS

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HOW TO USE THIS MANUAL

This manual is designed as a step-by-step guide to establishing a rural science outreach and education program. It is written for staff from:

- natural history museums,
- science and technology centers and museums,
- children's museums and discovery centers, and
- nature centers, zoos, aquaria, and other science-related programs with outreach and education missions.

The approaches described here are based on the experiences of a particular program, the New Mexico Rural Science Education Project (NMRSEP). NMRSEP focuses specifically on *rural elementary schools* and on *earth and life sciences* (i.e., geology, paleontology, zoology, and botany); that focus is reflected in the procedures and sample materials included in the manual. However, we believe that much of NMRSEP's experience is likely to be applicable to other educational levels; to other areas of science, from archaeology to the physical sciences; and even to suburban or urban environments. NMRSEP staff have worked, in limited ways, with middle school and high school teachers; staff have also adapted their approaches to include lessons in physics, chemistry, and anthropology.

The manual should be helpful whether your museum or center already addresses rural audiences or whether you are just now expanding your outreach activities. Experienced staffs may find new ideas to add to your repertoire, while those of you just initiating efforts will find structures and techniques to aid in developing these programs from the ground up.

Using NMRSEP as a model, the manual details the entire process of establishing a rural science outreach and education project within your museum or center. Chapters outline steps necessary to gain support from your museum's leadership; ways to find funding; the placement of your program within the organization; the selection of appropriate project staff; outreach strategies; tips for establishing effective partnerships; the identification and development of program content; and evaluation of your program's effectiveness. You may use the manual as a comprehensive guide to every phase in the development of a project like NMRSEP, or you may prefer to use it as a reference to specific program elements.

You may also find it helpful to refer to a companion document, written for rural school administrators and others providing training and other services to rural districts. The document, titled *Using Partnerships to Strengthen Elementary Science Education: A Guide for Rural Administrators*, describes the advantages and requirements of science partnerships from the perspective of rural school principals and superintendents. This manual also includes (in chapter 2) background information describing conditions, needs, and protocols in rural schools; however, the *Guide* may offer additional insights into the workings of rural schools and rural science instruction.

PREFACE

This manual has been developed through "Strengthening Science in Rural, Small Schools," a national dissemination project involving the cooperative efforts of three agencies: the Southwest Educational Development Laboratory (SEDL) in Austin, Texas; the New Mexico Museum of Natural History, located in Albuquerque; and the New Mexico Center for Rural Education located at New Mexico State University in Las Cruces. Funded by the U.S. Department of Education's Office of Educational Research and Improvement, "Strengthening Science" was designed to encourage the creation of hands-on science programs that link rural elementary schools with museums and other community resources. The major focus of "Strengthening Science" has been to package and disseminate a set of outreach and education strategies developed through an earlier program, the New Mexico Rural Science Education Project (NMRSEP).

The original NMRSEP project, initiated in 1986 with a grant from the National Science Foundation, was a joint venture of the Museum of Natural History and the Center for Rural Education. The NMRSEP approach capitalizes on the natural settings of rural schools to make science exciting, relevant, and achievable for both teachers and students. Through resource materials, workshops, and field trips, rural teachers learn about local wildlife, plants, rocks, and fossils and about science concepts and processes. Teachers also learn how to develop and use hands-on science activities that center on local natural history. These activities are designed to address curriculum goals and strengthen students' knowledge of science and their thinking skills. Finally, teachers learn about agencies that can provide additional information on the local environment. (A full history and description of the NMRSEP project is included in Appendix A.)

NMRSEP was identified as a "promising practice" by one of SEDL's regional programs, the Rural Small Schools Initiative, in 1987. On the basis of that assessment SEDL selected the project as the foundation for a successful competitive proposal that was submitted to the U.S. Office of Educational Research and Improvement during the summer of 1989. As a result, "Strengthening Science" was funded for one year to:

- develop an implementation manual for museum staffs, outlining NMRSEP's approaches,
- develop a guidebook for rural educators, describing ways of working effectively with museums and other community resources on projects like NMRSEP, and
- conduct demonstration workshops and a national dissemination conference based on these materials.

This manual was written by staff from the New Mexico Museum of Natural History, and SEDL. Its companion document, *Using Partnerships to Strengthen Elementary Science Education: A Guide for Rural Administrators*, was developed by the New Mexico Center for Rural Education with assistance from SEDL staff, and is available from either SEDL or the Center.

ACKNOWLEDGEMENTS

A number of agencies and institutions contributed to the success of both NMRSEP and "Strengthening Science in Rural, Small Schools" as well as to the development of this manual. The National Science Foundation provided funding for NMRSEP's first two years of existence; a grant from the New Mexico Commission on Higher Education extended the project's development for a third year. Thirteen rural New Mexico school districts -- Alamogordo, Bloomfield, Central Consolidated, Cobre, Cuba, Dulce, Eastern Navajo, Estancia, Hatch, Los Lunas, Magdalena, Ramah Navajo, and Zuni -- participated in NMRSEP activities and provided invaluable feedback regarding the utility of a range of educational strategies. Cuba Elementary School, and Katherine P. Gallegos and Peralta Elementary Schools in Los Lunas, graciously served as demonstration sites for the "Strengthening Science" museum educator workshops.

Credit also should be extended to numerous individuals for their supportive efforts. Don B. Croft, Everett Edington, Jeffry Gottfried, and Thom Votaw originally conceived NMRSEP (in the Owl Bar, San Antonio, New Mexico) and laid the groundwork for its inception. Gottfried and Croft provided leadership as principal investigators for the initial grant; Edington, Gottfried, Votaw, Belinda Casto-Landolt, Judy Dacus, Nora Hutto, Michael Judd, Theresa Martinez, Lynn Rogers, Michael Sanchez, and Rebecca Smith all worked as staff during the course of the project. Artist David North constructed several valuable exhibits for NMRSEP staff. In addition, Interim Director J. Edson Way, a host of curatorial, exhibits, and educational staff, and volunteers from the Museum of Natural History all offered time and assistance whenever it was needed.

Preston Kronkosky, Wes Hoover, and Martha Boethel from SEDL; Jon Callender, Michael Judd, Rebecca Smith, and Michael Sanchez from the Museum of Natural History; and Nora Hutto from the Center for Rural Education were all involved in conceptualizing the "Strengthening Science" project. Hoover, Boethel, Judd, Smith, Sanchez, and Hutto, along with O.D. Hadfield, Betty Rose Rios, Thom Votaw, and Fred Lillibridge from the Center for Rural Education, were responsible for the project's development, demonstration, and dissemination activities. Lori Snider at SEDL and Joan Barton and Alyce Waters at the Museum of Natural History provided invaluable support. Martha Boethel edited this manual; Rob Turner drew the illustrations. Rosalind Alexander-Kasparik at SEDL guided the manual's layout and design.

Providing expert review for outlines and drafts of the manual and/or guidebook for rural educators were: Carter Collins, SEDL's institutional liaison with the U. S. Office of Educational Research and Improvement; Jeffry Gottfried, now at the Oregon Museum of Science and Industry; Teri Lipinski, formerly a rural education specialist with the National Rural Development Institute and now a school counseling psychologist with the Kalispell, Montana, School District; Gretchen M. Jennings, Senior Museum Education Officer with the American Psychological Association; and Shirley Hord, Gayla Lawson, Pam Bell Morris, and Marianne Vaughan, all from SEDL.

Project efforts were greatly strengthened by the participation of ten teachers from rural New Mexico school districts. Debra Gurule and Pita McDonald from Cuba School

District, and Marilyn Gentry and Bobbie Salaz from Los Lunas School District helped with initial plans for the manual, guidebook, and project meetings; critiqued project materials; allowed observers into their classrooms; and helped conduct workshop and conference sessions. In addition, Joanne Montoya and Floyd Peña from Cuba, and Judy Carson, Kathleen Lerner, Angie Lucero, and Gloria Marcotte from Los Lunas allowed workshop participants to observe in their classrooms. The hospitality and cooperation of Joe Lopez and Hugh Prather, superintendents of those districts; Yolanda Denny, principal of Peralta Elementary School; Maribelle Ogilvie, principal of Katherine P. Gallegos Elementary School; and Edumenio Gurule, principal of Cuba Elementary School, are also deeply appreciated.

1. INTRODUCTION

Numerous studies indicate the critical need for improvements in American science education. U.S. students lag far behind their counterparts in the Soviet Union and Japan in preparation for advanced science. Fewer and fewer young people are pursuing scientific study or careers. Among the reasons are schools' failure to introduce students to science skills and concepts in the elementary grades, the use of outdated teaching methods and curricula, and the failure to relate science concepts to everyday applications.

Small rural schools tend to lag even further behind urban districts due to limited availability of science resources, funding, and trained teachers. The isolation of many rural schools makes growth opportunities for teachers in science education more difficult. Despite these deficits, however, rural schools are ahead of their urban counterparts in access to some important science teaching resources. The natural environment of mountains, deserts, forests, or coastline offers a context for the study of scientific methods and everyday applications that, taught in the elementary grades, can help hook students' interest in science. But to tap these resources teachers need access to knowledge about the rural school's local natural history, and strategies for relating this knowledge to the purposes and methods of the science curriculum.

The New Mexico Rural Science Education Project (NMRSEP) was established to meet rural schools' need for innovative, affordable ways to make science education both effective and exciting. Its approaches have worked well in New Mexico, and we believe it has potential for extension to museums and rural school systems nationwide.

What Is NMRSEP?

The New Mexico Rural Science Education Project is a cooperative outreach program designed to help rural elementary schools teach science using local natural resources. Through participation in workshops, field schools, and other project activities, teachers learn about their local environments. They also learn how to develop hands-on science activities with local natural history specimens and other inexpensive materials, and to use these activities to teach the concepts and processes of science.

NMRSEP is based on a philosophy of instruction that entails the following beliefs:

- Students (and teachers) can be excited by science, and can learn more effectively, if science concepts, processes, and facts are rooted in students' own environment and experience.
- Students (and teachers) learn more, and retain that learning longer, when they are actively engaged in the learning process, and when that process integrates several learning styles -- e.g., tactile as well as visual and auditory.

- To be effective, science instruction must address three elements: specific facts (e.g., sandstone is a sedimentary rock), science processes and concepts (e.g., how sedimentation occurs), and students' science process or thinking skills (e.g., observing and classifying sedimentary, igneous, and metamorphic rock). Facts are of little use without a grasp of the underlying processes; neither facts nor processes are of much value if such knowledge cannot be applied to solve problems or answer other questions.

- Effective teachers function as facilitators of learning rather than merely as repositories of knowledge.

NMRSEP centers attention on the value of using science and natural history museums as science resources. The New Mexico Museum of Natural History has played the central role in the achievement of NMRSEP's goals. The museum supplies resources in the form of educators and science curators with specialized skills and knowledge, as well as equipment, materials, and the riches of the museum's collections.

Why is NMRSEP special?

NMRSEP is special in several ways. It enables rural schools to transform the local landscape into a science classroom and laboratory. NMRSEP focuses on the kinds of instructional strategies that have proven to motivate students and to teach them both science content and skills in thinking and reasoning. Another unique characteristic is its individualized focus -- NMRSEP responds to the particular resources, needs, and circumstances of each school it serves. One of our primary goals is to familiarize teachers with their local natural and human resources, while textbooks and even the range of supplementary materials now available focus only on generic information.

Our customized presentations and resource manuals are unique, making accessible information that would take days, weeks, even months of effort for teachers to collect and absorb. NMRSEP allows schools to tell us the kinds of assistance they need, rather than offering only a predetermined and limited content focus.

NMRSEP also taps into the knowledge and experience of teachers who have lived in a given community for a long time, helping them to use that body of knowledge as they teach and encouraging them to serve as resources for the rest of their school. Treating teachers as resources and colleagues rather than merely as "clients" or students is another of our special features. NMRSEP is a teacher-centered program that recognizes both the value and the effort of the teaching role. NMRSEP staff present information to teachers in ways that are useful, fun, and not intimidating. Our willingness to assist teachers in any aspect of science teaching has helped us win acceptance as "their" resource personnel. Finally, NMRSEP offers a unique combination of services to schools -- from resource surveys to teacher education to modeling of instructional activities. By providing a variety of services, we can be more flexible in meeting each school's specific needs. And perhaps most important, by working with a single school over time, we are better able to develop the kinds of trusting, mutually respectful relationships that are essential to successful program adoption.

How can a rural science outreach project benefit museums?

Why should a museum, which has limited funding and over-stretched resources, take on a rural science education program? What are the benefits to the museum from this association and why are museums moving into this area?

Perhaps the most important reason has to do with the evolving educational mission of most museums. Increasingly, the leaders in our profession -- and our funding sources -- are recognizing that museums hold an important key to the enhancement of American public education. A report commissioned by the American Association of Museums states:

> Museums have yet to realize their full potential as educational institutions. We believe a new approach to learning in museums must be developed, one that does justice to the unique learning environment they provide. (*Museums for a New Century*, 1984, p. 59)

Nowhere is the potential for such new approaches greater than in urban, inner-city schools and in the kinds of isolated rural schools addressed by NMRSEP.

Projects like NMRSEP also offer tangible benefits to the museums implementing them. Staff from the New Mexico Museum of Natural History have found that NMRSEP benefits the museum in the following ways:

- It addresses the education and outreach functions of the museum's mission statement; it fulfills requirements of state and federal funding sources for extending educational benefits to the widest possible audience. In states like New Mexico, where rural areas include large minority populations, this means the additional benefit of increasing minority access to the museum's programs.

- It increases the number of people served by the museum's programs, reaching many who otherwise might never have contact with the museum. Field programs like NMRSEP also help to boost the museum's attendance; NMRSEP schools are more likely to arrange for field trips to the museum, and students urge their parents to make the museum a weekend or vacation stop.

- It strengthens and expands community relationships by increasing contacts with other local and state agencies and individuals. It creates favorable public relations for the museum and attracts the interest and support of new visitors who come to claim ownership in the museum.

- It supports the resource development efforts of the museum. Good museum programs result in increased memberships and association support, and increased revenues from admissions and grants, as well as donations to museum collections.

- It provides museum staff with experience in the region and state. This benefits staff by strengthening their sense of professional mission, building their confidence, and enabling them to form new professional ties with state and regional groups that will directly enhance the museum's efforts. Staff also expand their scientific knowledge about the state's natural areas as they research the natural features of new communities, and in many instances they increase their opportunities to collect specimens.

Components of a rural science education project

A variety of approaches and levels of effort are possible for a rural science outreach project, from "one-shot" classroom demonstrations to ongoing teacher education. The elements of NMRSEP's approach have evolved over three years of experimenting with "what works." Based on our experience, we recommend the following program components. However, if your resources are limited or your rural school audiences have particular needs or constraints, you may wish to pick and choose from the elements in this list:

- *A review of state and/or district science goals and requirements.* This enables teachers and museum staff to identify skills and knowledge to be addressed and areas where activities and materials can best be incorporated.

- *Field surveys and research on local natural resources performed for each school's community.* This includes documentation of the community's natural history and the natural materials and resource people likely to be available for the project.

- *Preparation of resource materials for teachers, based on the field surveys and research.* These provide background information, illustrations, bibliographies, suggested activities, and other materials tailored specifically to the school's environment.

- *Field trips and inservice workshops for teachers.* These learning opportunities for teachers focus on identification and interpretation of significant features and resources in the natural environment and on hands-on activities that teachers can try in the classroom. Inservice sessions give teachers the chance to focus on local natural history, science education concepts, and strategies for hands-on learning in the context of local and state curriculum and science goals.

- *Expansion of the education network.* The project introduces rural teachers to naturalists and scientists living in or near their communities who are willing to conduct educational programs in the schools, as well as to personnel from agencies like the U.S. Forest Service, Soil Conservation Service, Department of Fish and Game, and Bureau of Mines and Mineral Resources.

- ***Ongoing support from the museum.*** Support may include such areas as research and development of resource materials, staff consultations, classroom visits, and mailings. This also includes making available to the schools the learning resources of the museum in the forms of study collections, exhibits, curator skills and scientific knowledge, equipment and supplies for field studies, learning activity kits, posters, and other educational materials.

Each of these six program components is described in detail in subsequent chapters of this manual. In addition, we have included material about outreach strategies, administrative issues, funding possibilities, and evaluation methods.

2. WORKING EFFECTIVELY WITH RURAL SCHOOLS

Understanding conditions and constraints in rural schools

When you work with any constituency it is important to know your audience -- its characteristics, values, needs, constraints, and strengths. You may find as we did that rural schools, like people, must be known individually. Most urbanites, accustomed to the media stereotypes about rural America, are surprised by the diversity among rural schools. Some of the country's wealthiest, as well as poorest, school districts are rural. As a whole, rural schools are less likely than their urban counterparts to serve minority students or to employ minority teachers and administrators. Yet most states include rural districts with predominantly Hispanic, African American, or Native American populations; NMRSEP has worked with several districts whose student populations are almost entirely Native American. Rural schools also vary greatly in their facilities, curricula, staff resources, and attitudes toward change.

However, most rural schools share some general characteristics that may influence their responsiveness to your outreach efforts. In general, rural schools tend to be more resource-bound than other schools; rural economies tend to lag behind those in urban areas and also to depend on a single industry for their well-being. This means that rural schools are often short on equipment, supplementary materials, and funds to support special programs. School buildings and other facilities are often older and less well maintained than in urban and suburban districts, a factor that can affect teacher morale, the school's funding priorities, and, at times, your options for scheduling training sessions and other activities.

One of the scarcest -- and most precious -- resources in many rural schools is time. Given the trends in state and federal mandates for curriculum, assessment, and other forms of documentation, virtually all educators, rural or otherwise, are hard-pressed to do their jobs in the time available. Time pressures tend to be even more intense in rural schools. In very small schools, teachers and administrators often play multiple roles; teachers may teach more than one grade level, and the principal may double as teacher, bus driver, or maintenance worker. Some rural teachers, too, may work a second job to supplement teaching salaries that are usually much lower than those of urban and suburban teachers.

Finally, you may find that most schools in rural areas are more closely tied to the values, customs, and interests of their community than are city or suburban schools. Rural communities -- and rural schools -- tend to be more homogeneous than larger towns and cities, and schools and their programs must be careful to operate well within community norms. (It is true that all schools must function within acceptable community norms. However, the "zone of tolerance," as educational researcher Robert Herriott describes it, within which communities allow schools to function freely -- to offer new programs or ideas, to change the status quo -- tends to be narrower in small, rural communities.) This circumstance often results in resistance to change, particularly change that is initiated outside the local community.

All of these factors have implications, first for your outreach efforts -- the ways you contact schools and interest them in your program -- and second, for your ongoing relationships with the schools you serve. We suggest the following strategies:

- Whenever possible, publicize your program through sources that rural educators are likely to find credible. If your museum has a strong history in working with schools, you probably are in great shape. If not, you might consider a partnership or other cooperative arrangement with an agency that does. (See the next section on "Partnerships as an outreach strategy.") Or, if you have a board member or other friendly contact person with links to rural schools, you might ask her or him to write a letter of introduction to accompany your outreach materials. You can also announce your services in educational newsletters published by state teacher and administrator associations (for example, the New Mexico Association of School Administrators or the New Mexico Elementary Principals Association), the state department of education, rural education centers, or college and university programs. Presentations at professional meetings are another effective outreach strategy that enables you to benefit from the reputation of an outside source.

- As you plan your program, and as you describe your services, be especially attentive to the amount of time, energy, and resources you will require from schools and their staffs. Two of the greatest benefits -- and drawing cards -- for NMRSEP are that it focuses on low-cost strategies for teaching science, and that it does not demand more from rural schools than they can offer.

- Consider your activities with rural schools as a *cooperative effort* in which you and the school staff work together to identify and address the school's needs. In your outreach presentations, emphasize this cooperative approach and stress that your purpose is not to *impose* ideas or formulas, but to respond to each school and community's unique circumstances and needs. Always treat ideas and input from school staff with respect; a superior "missionary" attitude is to be avoided at all costs.

- Be aware that it takes time to build good working relationships that are grounded in mutual trust and respect. Be willing to take that time; communicate often with the schools you serve; and always follow through on your commitments, however small.

- Be sure to familiarize yourself with local cultural traditions and consider these as you plan and present activities (see chapter 9).

Note: If you wish to obtain more information about issues, trends, and conditions in rural schools, three good sources are: the National Rural Education Association (230 Education, Colorado State University, Fort Collins, CO 80523, (303) 491-7022), which publishes The Rural Educator and Country Teacher; *the National Rural Development Institute (Western Washington University, Bellingham, WA 98225), which publishes the* Journal of Rural and

Small Schools; and the ERIC Clearinghouse for Rural Education and Small Schools (Appalachia Educational Laboratory, P. O. Box 1348, Charleston, WV 25323, (304) 347-0400), which reproduces a variety of materials on rural education.

Partnerships as an outreach strategy

One way of easing your access to rural schools is to find a partner agency that already has strong ties with them. NMRSEP began with this strategy; the New Mexico Center for Rural Education was a valuable partner in facilitating the museum's access to rural schools, as well as in many other ways.

Partnerships offer much more than access; a partner agency can provide staff expertise in science, in teaching methods, or in the workings of the educational system. Sometimes a partner agency can provide resources -- materials, equipment, even funds. Partnership projects appeal to funding sources and can broaden your opportunities for grant funds or corporate contributions.

There are a range of possibilities for partner agencies in a project like NMRSEP, including science, rural education or small school centers and programs at area universities; the regional education service centers that exist in many states; non-profit educational research and development agencies with a focus on science or rural schools; regional educational laboratories; agricultural extension services; professional associations; other museums; and even private businesses. Many organizations are only waiting to be asked.

Partnership arrangements also have their costs. Generally, though not always, you must share resources in some fashion. And partnerships require work. You must work to establish effective relationships, set clear expectations for each party, maintain clear communications, and balance authority and responsibility. But more often than not, the extra effort and occasional grief result in a better, more stable program.

Deciding what schools to target

If yours is a new program, you most likely will need to begin your efforts on a relatively small scale. Even a well staffed, well funded program cannot serve every rural school in its service area, at least not if it offers the kinds of in-depth, ongoing assistance suggested in this manual. So you will need to set limits, or priorities. The following are some issues to consider in selecting schools.

Numbers. The number of schools to be served by your project will be perhaps your major consideration. This will depend on the funds available, your staffing arrangements, and the developmental status of the project. NMRSEP, for example, uses a team approach; its two staff members, with frequent assistance from volunteers, conduct all activities jointly. This team arrangement offers a number of advantages (see chapter 11); its major *disadvantage* is a reduction in the number of schools that can be served. If you have two full-time staff members and a cadre of reliable volunteers working as a team, you can probably offer intensive services to approximately 10 to 15 schools per year. If each of the two staff members works separately, with strong volunteer support, the number can increase to perhaps 15 to 20 schools. That is, each staff member could probably conduct a field survey, develop a customized resource materials packet, offer two day-long inservice sessions, and provide follow-up assistance; you could also plan and carry out a more extended summer teacher training program, or work with a few more schools that offer summer school. However, keep in mind that, no matter what your staffing arrangements, during the project's first year you will be able to work effectively with only a few schools. In particular, conducting your first few field surveys (see chapter 5) and developing your first resource manuals (see chapter 6) will take a great deal of time and effort.

Proximity and access. The proximity of the target school and its accessibility to project personnel are also factors in the selection process, particularly in some western and southwestern states where distances between communities are often great, and roads may vary from poor to impossible in bad weather. (To serve these areas a four wheel drive vehicle may be a necessity.)

The choices can be difficult because often the most remote and least accessible schools are the ones most in need and most appreciative of the services a rural science program can provide. On the other hand, the advantages of choosing a more central, accessible area are clear: More teachers and, therefore, more students can be served. NMRSEP's solution to this dilemma has been to work toward a balance, serving some schools from both ends of this spectrum.

Distribution. Depending on your institution's mission and priorities, and on your source of funds or basic program purpose, you may want to target schools based on a pattern of geographic or demographic distribution. For example, you may want to concentrate on schools that have high percentages of minority or economically disadvantaged students or other underserved populations. High dropout rates among poor and minority students, and the distressingly low numbers of African American, Hispanic, and Native American students who pursue science courses and careers, make serving these groups a priority.

Individual schools versus entire districts. Another question to consider in planning your outreach strategies is how many teachers you want to include in any given activity, and what mix of grade levels you can effectively address. Many rural schools will have only one elementary school, but some may have two or more. Do you aim to work with these schools individually, or as a group? Do you work with the first and second grade teachers in all three of a district's elementary schools, for example, or with all levels of teachers at a single school? There are advantages and disadvantages both ways. NMRSEP staff have preferred to work with all the teachers in a given school; we have found that teachers develop a team spirit, supporting each other and exchanging ideas and materials. We have also found that teachers often judge better than we do which concepts and activities are appropriate for which grade level, and that teachers can adapt our ideas to the needs of the students they teach. One possible disadvantage we see in this approach is that some teachers at different grade levels in a single school may present much the same material to their students. However, if teachers present activities appropriate for the science concepts and student process skills mandated for their students' grade levels, there should be no problem. The same natural resources can be used to teach any number of scientific concepts and processes.

Often a school district will want to send science teachers from the middle school or high school to your workshops. This situation presents some hazards: Since your program is geared to the elementary level, secondary teachers may be bored by some of your materials, especially when you are modeling and discussing specific learning activities. However, if you know in advance what level of teachers you will be addressing, you can help minimize this problem, by adding suggestions for activities appropriate to higher grade levels and by directing secondary teachers to books and resources appropriate to their levels. The middle and high school teachers participating in NMRSEP workshops have been strongly positive about their experiences, stressing the value to all teachers of learning about local science resources.

If you plan to group teachers by grade level, and if some of your target schools or districts are quite small, you may find yourself working with only a handful of teachers. If you can afford to do so, great; the results most likely will be terrific. If you need to address a larger audience, you can try to combine sessions for two or more nearby schools. But be careful: Remember that an individualized focus is the heart of this program.

How to identify specific schools or districts

Once you have determined some general parameters for your target audience, you can begin identifying and contacting specific districts and schools. First check with other programs or departments in your museum to identify any schools with whom they have worked. Confer with your partner agency, if you have one. Use any contacts you have within the educational community to get suggestions as to schools likely to be interested in or to need your services. State departments of education publish an annual directory of all public schools in the state; these usually include names and addresses for the district superintendent and individual school principals. There are also commercially published directories that include private as well as public schools, for example QED School Guides for each state (available from Quality Education Data, 1600 Broadway, 12th Floor, Denver, Colorado 80202-4912).

Contacting schools

The best approach to generating interest in your program is to use a variety of outreach strategies. NMRSEP mails flyers to targeted schools, places announcements in the museum's newsletter, and makes presentations at the museum's frequent "open house" activities for school staffs and at area conferences. When the project first began, we were also able to draw on the reputation and contacts established by the New Mexico Center for Rural Education. Once the project staff developed good working relationships with several schools, other districts became even more interested.

One important thing to remember is to follow protocol. The school district superintendent should always be your first contact in any dealings within that district. You may want to target your mailings to elementary teachers or to principals, since they are the ones likely to be directly involved with your program. If you do so, however, be sure to send a copy of your announcement to the superintendent with a letter describing who you are contacting. Often it is a good idea to ask the superintendent's permission before contacting anyone else.

If you rely on mailings, you may need to make some follow-up telephone calls in order to get your materials noticed. Like the rest of us, school staffs are inundated with junk mail, and good things sometimes get tossed with the junk. (Again, be sure to start with the superintendent.) Maintaining frequent contacts with participating schools is also the best way to ensure continued enthusiasm and momentum in your program and to work out any problems as they occur.

Establishing working relationships

Once a school or district has expressed its interest, you can begin working out a specific plan of service. The following suggestions can help you maintain good will and good working relationships with the schools you serve.

Identifying a working contact. To work within a school district, you need the approval of the district superintendent. To work with a specific school, you need the approval and good will of the school principal. These, then, are the people with whom you will finally need to negotiate your service arrangements. However, superintendents -- and a great many principals -- tend to be incredibly busy and also somewhat removed from the daily instructional routine. It is helpful, then, to have someone else within the school or district designated as your working contact. This person might be a teacher or instructional supervisor, someone closely involved with and knowledgeable about the needs and schedules of the teachers you will be addressing. Your working contact should be able to help you work out plans and schedules, and to serve as your link both to teachers and the school administration.

It will be up to the superintendent or principal, of course, to designate an official contact person for your program. If, as sometimes happens, the "official" contact turns out not to be a real "working" contact, you will need to cultivate your own informal working contacts as you get to know the teachers. (Unfortunately, you will encounter teachers or other staff members who think they know all there is to know about science instruction, and others whose priority is not to improve instruction but to "get ahead" in the system.) However, *always be sure to follow protocol*; never ignore or bypass the official channels, simply add another, informal channel if it is needed.

Setting up cooperative agreements. A critical factor in maintaining good relationships with school personnel is to clarify expectations -- what they can expect from you, and what commitments of time and resources you expect from them. A written cooperative agreement can be a helpful tool in this process. A cooperative agreement can take the form of a formal instrument, similar to a contract, that is signed by authorities from both agencies; or it can be simply a letter to the superintendent that spells out your understanding of the commitments and responsibilities of both parties. Whatever its form, the agreement should note:

- the services you plan to provide and the audiences to be served,
- a general schedule for those services,
- any materials, equipment, or other resources your program will provide,
- any payment, facilities, equipment, materials, staff support, or other resources or special arrangements you expect from the school,
- the name of the school's designated contact person, through whom you will communicate with school personnel and handle all arrangements, and
- the name of your program's designated contact person, to whom the school can turn for information and assistance.

Maintaining contact and following through. We have found that the more you keep in contact with schools, the better things work. A phone call to check progress on arrangements, a letter summarizing the plans you made at your last meeting, follow-up phone calls or visits after a training session to "see how things are going" -- these do a lot to avoid problems and build trust.

The other critical element in working with schools is to meet your commitments. Remember that schools lack the flexibility that many of us take for granted in our working lives; they operate on rigid schedules and under strict regulations. If you arrive late for a field trip or field school, for example, you may throw off the school's whole schedule for substitute teachers, buses, or other classes. If you fail to deliver materials promised to a teacher for a science lesson, you may disrupt an entire week's worth of lesson plans. Small failures can be magnified in a rural school environment, and may destroy your effectiveness no matter how great a program you offer.

3. WORKING EFFECTIVELY WITH TEACHERS

Teachers are the key to making NMRSEP effective. You may gain administrative support through the outreach strategies described in the preceding chapter, but if teachers fail to perceive the value of your program it cannot succeed. There are a number of issues to consider as you begin working with rural teachers.

Understanding teachers' constraints and concerns

Workloads. As mentioned in the last chapter, all teachers these days have overloaded work schedules. The push for educational reform and accountability that began in the mid-1980s has resulted in numerous state laws and regulations calling for new testing procedures, new curriculum offerings, special programs, and extensive documentation. Rural school staffs, who often have multiple roles already, are perhaps hardest hit by these new demands.

In addition, teachers often have strict requirements for the kinds of subjects they teach, the amount of time they spend on each subject, and the material they must cover in that time. Planning instruction to meet these requirements is work enough; adding new topics or expanding one subject means both working extra and trying to manipulate a rigid schedule.

The result of all these circumstances is that few teachers can embrace a new program requiring a great deal of extra time and effort. NMRSEP learned this lesson the hard way. The project began with a plan for helping elementary teachers to develop science learning kits. The kits, which focused on teaching process skills through hands-on activities, were intended for teachers to use in their own classroom and also share with other teachers. NMRSEP staff developed sample kits containing natural history specimens, background information, classroom activities, and resources for students wanting to learn more about the kit's topic. NMRSEP staff also conducted training workshops, led field trips for collecting specimens, and visited schools to provide resource materials and assist teachers in planning and constructing their kits.

Some teachers produced kits and planned field trips and classroom activities that were imaginative and effective. Most teachers were enthusiastic about the project's training and support activities and, over time, produced some classroom materials that were useful to them. In general, though, the "kit" approach was not successful, because it required too much time to collect specimens, research their background, plan activities, make materials, and write up the activities.

This is not to say that teachers are unwilling to make extra efforts to improve their teaching; far from it. But the extra work must be at a *manageable level* -- and teachers must perceive a payoff.

Instructional fads and fashions. Another thing to keep in mind is that teachers are constantly being introduced to "promising" new instructional approaches and materials. Since the 1960s, one "solution" after another has swept through the educational system, from open classrooms to career education to basic skills to direct instruction, naming only a few. Whatever the individual merits of this great variety of programs, their common characteristic has been to require that teachers adapt to yet another new method or curriculum or room arrangement. Many times the teachers themselves have had no voice in the decision to adopt a new program, and little or no opportunity to express concern or help modify the program to meet local circumstances. As a result, most teachers tend to be cynical about new programs, especially those selected without their input, and to take a "prove it to me" attitude about promises of success.

Lack of confidence in teaching science. Another barrier we have encountered in trying to involve teachers in NMRSEP is their frequent lack of training, experience, and confidence in teaching science. At the elementary level, and especially in the lower grades, science gets much less attention than other basic subjects. Teacher education and inservice programs for elementary teachers are rarely geared to science instruction, especially the kinds of interactive, process oriented teaching that NMRSEP stresses. Many elementary teachers are intimidated by science and by any program seeking to make the subject a bigger part of their instructional routine.

Motivating teachers

At NMRSEP, we have found working with teachers a pleasure rather than a chore. Teachers are amazed at the science that is all around them. They enjoy discovering that science is not some esoteric subject removed from daily life. Over and over, teachers, administrators, and students alike have greeted the specimens, information, and ideas brought by museum staff with interest and enthusiasm.

It is possible to offer a program that overcomes the barriers listed above, exciting teachers' interest and motivating them to try the things you suggest. The fastest way to motivate teachers is to *address the needs they perceive themselves*, in the ways they believe will be most effective. If a teacher is the person in a school or district who first notices your program, and if he or she asks the administration to sign up for your services, half the battle is already won. You will have at least one strong advocate on the instructional staff. If, on the other hand, the superintendent or principal has called you in without involving the instructional staff at all, you will have some extra work to do. Here are some suggestions for improving your effectiveness with teachers.

Program design and outreach. As you plan your program, be sure to factor in teachers' time constraints. Focus as much as possible on providing teachers with materials and activities they can easily incorporate into their regular routine; link your information, materials, and suggested activities to the science concepts and skills teachers are mandated to address. Plan services that will allow you to respond to teachers' individual requests for assistance. Highlight these characteristics in your outreach materials and presentations; also emphasize the fact that, in focusing on the school's local environment, your program draws on the inherent knowledge teachers have about the area in which they live.

Another way to address teachers' time constraints is to emphasize the integration of science instruction with other areas of the curriculum. Especially in the early elementary grades, teachers usually have only a couple of hours each week to teach science; requirements for reading, mathematics, and other subjects tend to crowd science off the schedule. By integrating science with other subjects, teachers can make more room for science and also strengthen instruction, since integrated instruction can help improve students' motivation to learn. Science is a natural companion to many other subjects, as these examples illustrate:

- Science and language arts can be integrated through activities in which students record written observations of experiments or natural phenomena, write poems or stories with a nature theme, or formulate and discuss hypotheses either orally or in writing. Project Learning Tree and Project Wild activities (see chapter 6) often incorporate language arts into their activities.

- Mathematics can be linked to many science activities through measurement and graphing of plant growth, bones, speed of stream flow, or other phenomena; through calculation of time, distance, or temperature; and, for younger students, through counting numbers of teeth on leaves, legs on spiders and insects, rock layers in a formation, and the like.

- Art is ideal for integrating science activities, by making murals or dioramas of prehistoric scenes, dying yarn with native plants, making sand paintings with locally collected sands, or using seeds as an art medium.

- Project Wild (see chapter 6) has several activities that can be used in physical education, including "Oh Deer!" and "How Many Bears Can Live in This Forest?"

Involving teachers in planning. As you can, encourage school administrators to involve teachers early in planning your services for the school. If given the opportunity, you may want to suggest that your designated contact person be a teacher, preferably one with some enthusiasm for science and some standing with the other teachers. Or encourage the establishment of a teacher planning committee with which you can work to identify needs and lay out a service plan. Survey all teachers about their experience, needs, and resources. (Some sample survey forms that NMRSEP uses are included in the next chapter.) Then be sure to use the information you collect as you plan your activities.

Making teachers' lives easier. Schedule your program activities for the convenience of teachers, not your own calendar. As you can, avoid after-school or Saturday sessions that infringe on teachers' personal time. If you receive grant funds for your program, try to include at least some funds to cover teacher stipends, especially for weekend or summer sessions. If you offer an extended education program, such as the week-long Summer Elementary Science Teachers' Institute (SESTI) offered by NMRSEP, try to arrange for teachers to receive college or continuing education credits for participating. College credit may be arranged through the Education Department at a university (often museum staff members will have links with a university, as an adjunct faculty member or guest lecturer). Continuing education credit is used in many states as one yardstick for assessing teachers' pay grades or career ladder status; contact your state department of education to obtain criteria and procedures.

Treating teachers as professionals. Perhaps the most important element in working with teachers is your attitude toward them. Recognize them as professionals; treat them as equal participants in a partnership. Be open to their suggestions, questions, and concerns; use them as resources to learn about the local environment and to generate new ideas for learning activities. As we stressed in the preceding chapter, it is also essential to follow through on any promises you make to a teacher.

4. SURVEYING A SCHOOL'S NEEDS

The first programmatic step to take in working with a particular school or district is to learn as much as you can about the school's needs and available resources. A needs survey will provide you --- and the school -- with important information to consider as you develop program content. Many schools have equipment, collections, and other materials that are rarely used because teachers do not see their value or feel competent enough in their use. Finding out what resources are sitting in the backs of school storage rooms may suggest a content area to cover or a session on how to use unused equipment. Finding out what equipment and resources the school lacks will help you avoid the mistake of teaching teachers to do activities that they do not have the resources to conduct in their classrooms. By pointing out the usefulness of some equipment the school is lacking, you may also help teachers begin the process of acquiring it. It is also important to find out more about the teachers with whom you will be working. What is their background in science? How do they teach science? What kinds of training and support do they think they need?

NMRSEP has developed two survey forms, one to collect information about the school's general science activities, resources, and needs, and the other focused specifically on possible inservice topics. Sample forms are presented on the following pages.

If possible, survey every teacher with whom you will be working. Conduct the survey as far ahead of your first scheduled education program as possible. In a cover letter, briefly explain who you are, the goals of the project, and the primary methods you would like to use to meet those goals at the school. Ask teachers to fill out the forms and return them to your designated school contact person by a certain date. (You will find that teachers are more responsive if their principal, the school contact person, or teacher planning committee, has already informed them about the project.)

Once you have conducted the survey, be sure to use the results in planning your education and support services for that school. (The quickest way to alienate an audience is to ask for input and then ignore the results.) Go over the survey responses with your school contact person or teacher planning committee and seek their ideas about setting priorities. When you work with teachers, refer to information from the survey as you introduce topics or activities. If possible, write a brief summary of the survey results and provide a copy for every teacher surveyed. You will find that, in many schools, teachers and other staff know surprisingly little about each other's activities, perspectives, and resources; they generally are eager for such information. You can gain a lot in good will through small courtesies like this one.

Science Teaching Resource Inventory

1. What grade level(s) do you teach?

2. Are you responsible for your students' science instruction? If not, who is?

3. How much time each day or each week does your class spend on science?

4. What science textbook series do you use?

5. What other science education materials do you use?

6. What major science concepts and content areas are covered in the grade you teach?

7. To what types of equipment do you have access for teaching science in your classroom?

8. To what type of specimens do you have access for teaching about natural science?

   a. Rocks and minerals:
   b. Fossils:
   c. Plant materials:
   d. Bones, feathers, live animals, etc.:

9. To what kinds of reference or background resources (such as field guides) do you have access?

10. How many field trips or other outdoor science activities do you conduct during the school year?

11. Where do you usually go on field trips?

12. What kinds of hands-on activities do you use in teaching science?

13. What problems have you encountered in teaching science?

14. Would you like assistance with strategies and activities for teaching hands-on science?

15. Would you like assistance in relating your science curriculum to the local environment?

16. Would you like assistance in developing specimen collections for teaching science? If yes, which types of collections?

17. Would you like instruction in using scientific equipment? If yes, which types?

18. Is there other assistance the museum could offer you or your school?

Inservice Needs Assessment

Please choose five areas for which you would like information, instruction, or other assistance. Prioritize them from 1 to 5, with 1 the most important and 5 the least important.

	1	2	3	4	5
Birds: information, birds of your area, classroom activities					
Fossils from your area					
Skeletons and teeth of native wildlife: information and classroom activities					
Plants in your area					
Dinosaurs: information and activities					
Insects: background information and classroom activities					
Rocks/geological formations: information on your area, identification of rocks, help with beginning a collection					
Mountain life zones: looking at the life zones in mountain communities, plant and animal life in each, and classroom activities					
Cycles in nature: information and activities					
Energy and energy cycles: information and activities					
Interdependence among animals and plants in different environments: information and activities					
Ways to protect and conserve the natural environment					
How scientists make discoveries and test hypotheses					
Field trip discussing natural resources in the area (rocks, plants, habitats, etc.)					
Help with development of a nature trail near your school					
Help in using the above resources to fulfill your science goals					

Other topics (please describe):

5. CONDUCTING A FIELD SURVEY

A second step you will need to take before you begin conducting teacher workshops is to conduct a field survey trip. It is important to be familiar with the resources in the area of the school so you can help teachers develop activities using these resources. Many rural schools have fantastic natural resources nearby that teachers are unaware of or uncertain how to integrate into the curriculum. For example, teachers from Newcomb Elementary School were surprised to find an enormous wall of solidified magma across the highway from their school. What better resource for teaching about the rock cycle? Teachers in Los Lunas were excited to find that ostracods, tiny seed shrimp, were living in the drainage puddle on the playground -- a perfect opportunity to get out the hand lenses and microscopes.

Look for areas that might be good *field school* sites. (Field schools are described in chapter 8.) An area with a pond or stream, exposed rock layers, and a variety of trees and plants is ideal. For the field school, stations will be set up around special resource areas. A sandy area is a good place to do a "Fossil Dig" activity (described in chapter 6). An area with different kinds of lichens makes a good lichen station for studying symbiosis. A limestone or shale outcrop might provide marine fossils. Reeds around a pond would be a good bird-watching site.

The best *field trip* sites for school classes are within walking distance of the school, but some schools may be able to bus students to sites further away. Field trips just for teachers can be away from the school, as teachers can use knowledge gained at the site in the classroom, whether or not they can take students there. A field trip for teachers may stop at several sites in the area (for example, a swampy location, a forested location, a road cut, and a field). Remember, your purpose is to familiarize teachers with the natural history and science resources of the region, not just to provide field trip sites for their classes.

Surveying the natural resources of the area will help you to compile a resource manual (see chapter 6) and to develop ideas about ways that teachers can use local resources in hands-on activities. Keep in mind that what seems obvious to you, e.g., the rock outcrop across the street from the school or the pond near the playground, may never have been noticed by teachers.

A survey trip to a rural area generally takes one to two days, depending on distance. During the trip, observe the natural environment, but also talk to local experts and visit local agencies to obtain resource materials and possible assistance with the project. People are generally enthusiastic about telling you about the road cut with fossils in it, the riparian area where they have seen many birds, or the history of land use in the area. Check in at the school to speak with administrators and teachers. Find out (from your resource survey, described in chapter 4, and from follow-up conversations with teachers) where teachers take their classes on field trips and what land use restrictions there may be. Also ask about other local resource people to contact, whether or not the school has a nature trail, where ponds, streams, and springs are in the area, and where quarries, mines, and interesting roadcuts can be found. If possible, you may want to take one or two teachers with you as you explore the area; it will be a good learning opportunity for them and will provide you with a local "guide."

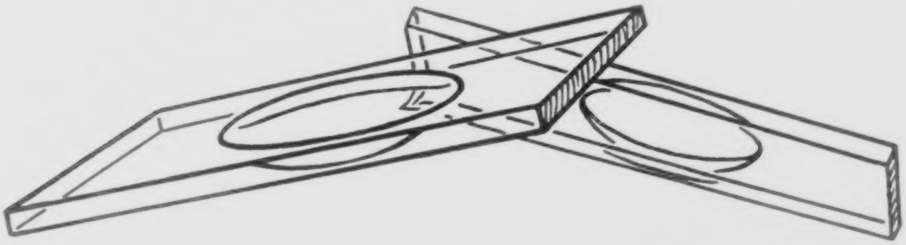
Equipment and resources you will need

The following equipment and resource list contains the basics for collecting the information you will need about an area's natural resources. A list of suppliers also follows.

- ***A traveling companion.*** Your most important resource on a field survey is a partner. To be able to investigate back roads and wilderness areas, you need always to travel in pairs for safety's sake. And another pair of eyes is helpful anywhere -- especially when one pair needs to focus on the road!

- ***Vehicle.*** Our survey trips have inevitably led us down dirt roads and, therefore, have required an adequate vehicle. Many rural school buses are equipped with 4-wheel drive so field trips down poor roads are not impossible.

- ***Microscope.*** A compound microscope can prove useful in examining aquatic life in ponds and streams. You will need slides (well slides are great for examining pond life specimens), and coverslips; a petri dish can be helpful. Binocular microscopes that do not have a light source and go up to 30 power are another valuable resource. A dissecting scope is useful for examining insects and flowers.

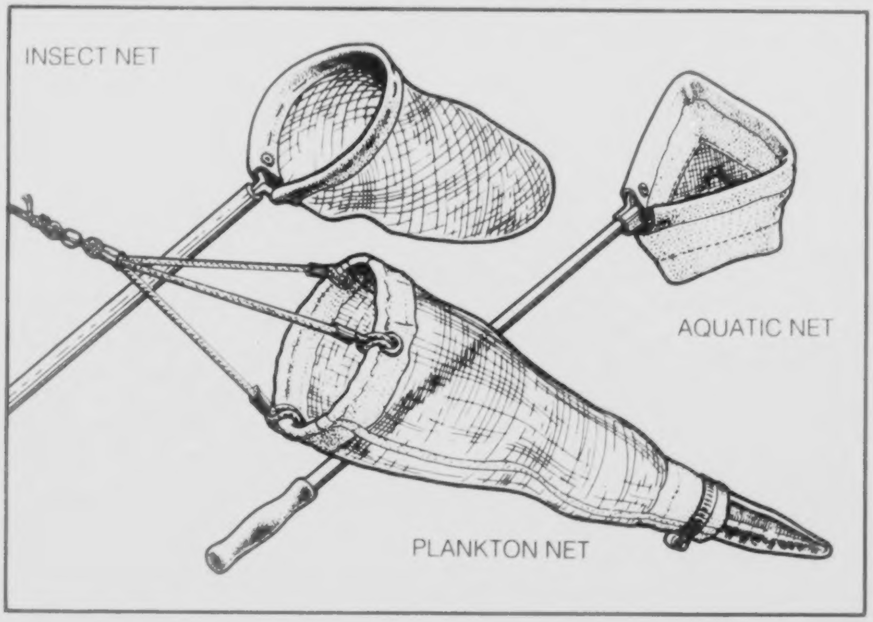


WELL SLIDES

- ***Binoculars and hand lenses.*** Binoculars are useful in sighting birds, as well as elusive mammals, reptiles, and new areas worth exploring. A hand lens will allow you to identify small crystals, insects, and flowers.

- ***Camera.*** A camera is a lifesaver for recording the survey trip in preparation for writing the resource manual, as well as for preparing instructional slides. Slides are more useful than prints because they can be projected to a large size, can be shown during workshop sessions, and still can be converted to prints through an internegative process. Slides also take up less space than prints. A video camera is ideal for documenting survey trips, as well as later teacher education programs and project results. A video on the natural history of the area could be kept in school libraries as a companion to the natural resource manual.

- ***Collecting equipment.*** In any laboratory, especially one as large as the "great outdoors," the unexpected can and will occur. To be properly prepared for serendipitous discoveries requires having an array of collecting equipment handy. Generally useful items include ziploc baggies, garbage bags, a bucket, jars, and nets. (Before collecting any specimens, however, refer to the section "Developing Educational Specimen Collections" in chapter 7 for important information on collecting ethics and laws.) Other collecting equipment we recommend:



  - For collecting and examining aquatic samples, use aquaria, aquatic nets, plankton nets, jars, test tubes and petri dishes, well slides, eyedroppers, and binocular microscopes.

  - For collecting other zoological samples you will need a cooler for holding roadkills, plastic trash bags for bones, and gloves to protect from disease. Feathers and snakeskins can be kept in bags. (See chapter 7 regarding the hazards of collecting animal specimens.)

  - For collecting geological specimens, you will need jars and vials for colored sand samples, a rock hammer and chisel or paint scraper to split shale, newspaper for wrapping rocks, and boxes to put them in (beer flats work well). Hydrochloric acid (HCl) can be used to test for limestone.

  - For collecting paleontological specimens, we recommend the following: For collecting small, invertebrate fossils such as trilobites, shells, and coral, ziplocs with paper towel padding may be sufficient. Fossil plant specimens are often preserved in shale. They can be very delicate and require special treatment to prevent them from shattering; these may be best removed onto flat cardboard trays. This procedure would pertain to delicate invertebrate fossils in shale as well. Small vertebrate fossils such as shark teeth and gar fish scales may be found abundantly in some areas, and film canisters serve well to collect these. (Collection of vertebrate specimens should only be done under the supervision of a trained paleontologist; see "Developing Educational Specimen Collections" in chapter 7.)

- ***Plant press.*** A plant press will allow you to begin a herbarium for area teachers and for the museum's collections.

- ***Maps.*** Maps to take include topographic quadrangles, geologic quadrangles, highway maps, and forest service maps. Topographic maps are essential, as they will help you locate the schools and ranger stations, and, most importantly, avoid getting lost! A compass is necessary in using topo maps.

- ***Field guides.*** Field guides are useful for field identification of insects, birds, mammals, rocks, and minerals. Regionally pertinent ones are the best, especially for geology and paleontology. Some suggested field guides are:

  - *Simon and Schuster Guide Book Series,* published by Simon and Schuster, New York. This series covers a range of topics, including plants and flowers, trees, rocks and minerals, shells, and many more. All are illustrated and photographed in color.

  - *Golden Field Guide Series,* Western Publishing Company, Inc., published by Golden Press, Racine, Wisconsin. This series also covers a wide variety of subjects, including birds, trees, rocks and minerals, amphibians, reptiles, and many more. All the books are illustrated in color and are easy to use as the pictures and text are all on the same page.

  - *Golden Nature Guides,* published by Golden Press Inc., New York. This series is an ideal introductory guide to nature. Topics range from birds to zoology. As an added benefit, all are in color and include distribution and occurrence maps.

  - *The Audubon Society Field Guide Series,* a Borzoi Book, published by Alfred A. Knopf, Inc. All are comprehensive field guides on a wide range of topics. Photographs are in color.

  - *Audubon Society Nature Guides,* a Borzoi Book, published by Alfred A. Knopf, Inc. These guides are arranged by habitat, each book containing the birds, reptiles, amphibians, insects, wildflowers, and much more of each zone.

Topics are: deserts, wetlands, Western forests, Atlantic and Gulf coasts, grasslands, Eastern forests, and Pacific coast. All are illustrated and photographed in color.

- *Peterson Field Guide Series*, published by Houghton Mifflin Company, Boston. There are 26 topics covered in this series, including a guide to the atmosphere, bird's nests, and more.
- *Stokes Nature Guides*, published by Little, Brown and Company, Boston. This series includes guides on observing insects, nature in winter, and bird behavior. All are unique in that behavior and life-cycles are discussed. Stokes Nature Guides provide the basis for many natural science activities.
- *Field Guide to Tracks of North American Wildlife*, by Myron and Charles Chase, published by NASCO, Fort Atkinson, Wisconsin. This book covers dozens of tracks, all actual size, of North American mammals and birds.
- *Mammalian Osteology*, by B. Miles Gilbert, 1980, B. Miles Gilbert, Publisher, 709 Kearney, Laramie, Wyoming, 82070, Library of Congress No. 80-84455. This book represents many skulls and other bones of animals life-size for direct comparison with specimens.

Deciding what to survey

Any natural site within the school district could be useful to survey as it will allow teachers to understand the natural history of their community. For example, students may bring in a fossil from near their home or ask about the trees in the mountains where they live; the results of your field survey can help prepare teachers to respond to such situations. During the survey trip, however, you will face time constraints as well as problems with access to resource sites, so it is helpful to do some planning ahead of time.

Look at topographic maps for areas of relief, such as cliffs and buttes, which are likely sites for rock and fossil exposures. Streams, ponds, lakes, and springs are also indicated on topographic maps. A geologic map will indicate areas of igneous intrusion and volcanic fields, as well as different geological formations that may be of special interest, such as hogbacks, faults, basins, mines and coal seams, or fossil localities. A land status map that specifies ownership is very important if specimens are to be collected; Forest Service maps often show land status. It is critical to know collecting laws and ethics for any specimens you want to collect! (See chapter 7.)

Museum staff, especially curators, may have done field work in the area you are surveying and may have information about its natural history. Fossils may have been collected; there may be rare or endangered plants or special birds or mammals. School staffs may also know of places that might otherwise be missed in the survey. A natural spring, an owl's nest, or packrat midden might be located with their help. Other local resource people like parents and staff of other agencies should also be consulted. Local

Equipment Suppliers

Forestry Suppliers, Inc.
205 West Rankin Street
Post Office Box 8397
Jackson, MS 39204
(601) 354-3565

BioQuip
P.O. Box 61
Santa Monica, CA 90406
(213) 324-0620

Fisher Scientific
4901 W. LeMoyne St.
Chicago, IL 60651
(800) 621-4769

Carolina Biological Supply
Company
Powell Laboratories Division
Gladstone, OR 97027
(503) 656-1641
Order (800) 547-1733

Geoscience Resources
2990 Anthony Road
Burlington, NC 27215
(800) 742-2677

Edmund Scientific
101 E. Gloucester Pike
Barrington, NJ 08007-1380
(609) 573-6250 or 573-6295

Sargent-Welch
Central Regional Office
7350 North Linder Avenue
P.O. Box 1026
Skokie, IL 60077-1026
(312) 676-0172 or (800) 727-9600

Carolina Biological Supply
Company
Main Office and Laboratories
Burlington, NC 27215
(919) 584-0381
Order (800) 334-5551

Ward's Natural Science
Establishment, Inc.
Rochester, NY
Santa Fe Springs, CA
Order (800) 962-2660

Educators Guide to Free Science
Materials
Educators Progress Service, Inc.
214 Center Street
Randolph, WI 53956
(414) 326-3126

Note: Many of these suppliers will provide catalogs on request.

naturalists, bird-watchers, hunters, trappers, hikers, or ranchers can provide interesting information about local wildlife. Here are some examples of agencies and organizations to contact: Audubon Centers, the state Audubon Society, U.S. Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service, U.S. Soil Conservation Service, local museums, native plant societies, state game and fish department, state department of agriculture, state department of forestry, state bureau of mines and mineral resources, state parks, state wildlife federation, and tribal resource management agencies.

Just driving down different roads in the area can prove interesting. We drove down one road just to see where it led -- and found nine volcanic dikes protruding from the cliffs! Another road taken by chance led to an old mine where the owner allowed teachers to collect specimens for their classrooms.

On a survey trip to Cuba, New Mexico, we observed two kinds of ants, petrified wood that could be compared to modern wood, two different types of juniper and pine trees to compare, clay to study and make pottery with, lizards, rodent burrows, lichens, a copper mine, and a pronounced fault zone.

Other discoveries included a roadcut where the children could collect gypsum crystals, coal, and sandstone, swampy areas with amphibians, and a montane forest with wildflowers. The list on the following page suggests some items to look for on your survey trips.

Getting teachers involved in field surveys

As noted earlier, teachers can point you in helpful directions as you conduct your field surveys. You can also enlist teachers' active participation and even help them plan and conduct their own field surveys. For some teachers, doing field surveys becomes an ongoing activity that continues throughout the year and actively involves their students.

To help teachers begin to conduct their own field surveys, start by suggesting local resource people that teachers can contact for information or suggestions about likely field survey sites. These may include the following: Boy Scouts, Girl Scouts, Chamber of Commerce, city or county forester, county agricultural agent, Farm Bureau, garden clubs, libraries, local branches of national societies, museums, nature centers, newspapers, park superintendents, science hobby clubs, Soil Conservation District manager, sport and conservation clubs, superintendent of sewage disposal plant, TV and radio stations, and Water Board.

Also suggest written materials teachers can refer to, and equipment or supplies they might need. Remember, though, to "keep it simple," since teachers will not have access to the resources you do.

For teachers to survey the trees in their community, they might obtain a map like "The Vegetation Map of the Southwest" and its corresponding guide produced by the U.S.

Examples of What to Look for on a Survey Trip

Wildlife

a. Amphibians
b. Birds
c. Insects
d. Mammals
e. Reptiles
f. Bones
g. Skins
h. Feathers
i. Indicative droppings
j. Owl pellets
k. Tracks

Plants and Fungi

a. Flowers
b. Grasses
c. Shrubs
d. Trees
e. Lichen
f. Fungi
g. Moss
h. Algae and water plants

Earth Science

a. Fossils
b. Minerals
c. Rocks
d. Landforms: buttes, cuestas, monadnocks, hogbacks, canyons, arroyos, cliffs
e. Mines
f. Quarries
g. Dikes, volcanos, sills, lava flows and tubes
h. Arches
i. Caves, sinkholes
j. Examples of erosion

Habitats

a. Ant hills
b. Burrows
c. Lakes
d. Marshes
e. Forests/woodlands
f. Ponds
g. Springs
h. Streams
i. Swamps
j. Grasslands

Forest Service. This will indicate life zone areas. Field guides for trees are also helpful. A survey of the geologic and paleontologic resources in the area requires geologic maps and locally pertinent geologic and paleontologic publications. A participating teacher could survey the wildlife in the area simply by keeping a list of wildlife that has been seen in the area. Other teachers, students, and parents could report sightings to the teacher in charge of the list. The list could include the name of the animal, who saw it, where it was seen, and the time of day.

The list can be kept in a loose leaf notebook for the entire school year; a new list can be started each year to compare with lists from previous years. This list might be divided into birds, mammals, reptiles, amphibians, and insects. The wildlife survey can be an on-going project challenging many classes of students. In the process of observing, recording, and compiling information, students will be supplied with the raw material for many wildlife-oriented activities that focus on specimens and involve students in the processes of science.

Finally, to help teachers structure and focus their field surveys, you might suggest the use of a field survey inventory or data collection form. A sample form is included on the following pages.

Teacher Field Survey Inventory

DIRECTIONS: This form is designed to help you and your students systematically survey the natural resources of your community. Using these resources, you can develop or adapt hands-on science activities for your students.

PLANTS

1. What are the dominant types of trees (plant communities) found near your school? (e.g. piñon-juniper, ponderosa pine, etc.)

2. Name 5 wildflowers that you can identify in your area:

1.
2.
3.
4.
5.

3. Name 3 grasses you can identify around your school:

1.
2.
3.

BIRDS

1. Name 5 common birds in your area:

1.
2.
3.
4.
5.

2. Name 5 birds that winter in your area:

1.
2.
3.
4.
5.

3. Is your school within a migratory flyway? If so, what are some of the birds that use it?

4. Name 5 birds that breed in your area:

1.
2.
3.
4.
5.

INSECTS/INVERTEBRATES

1. Name 10 common insects from your area:

   1.
   2.
   3.
   4.
   5.
   6.
   7.
   8.
   9.
   10.

2. Name 5 invertebrates that live in the water near your school:

   1.
   2.
   3.
   4.
   5.

REPTILES AND AMPHIBIANS

1. Name 5 species of reptiles found in your community:

   1.
   2.
   3.
   4.
   5.

2. Name 5 common amphibians found near your school:

   1.
   2.
   3.
   4.
   5.

MAMMALS

1. Name 5 predators that live in or near your community:

   1.
   2.
   3.
   4.
   5.

2. Name 10 plant eaters (herbivores) that live in or near your community:

   1.
   2.
   3.
   4.
   5.
   6.
   7.
   8.
   9.
   10.

EARTH SCIENCE

1. If you want to teach about the rock cycle, where, near your school, can you go to collect specimens of :

    1. Sedimentary rock:
    2. Metamorphic rock:
    3. Igneous rock:

2. What geologic time periods are represented in the rocks in your community?

3. What fossils have been found in your community/state in the rocks of that age?

4. Is there any evidence of volcanic activity near your school? If so, when did it occur?

    Where is it located?

ENVIRONMENTS/ECOSYSTEMS

1. Describe two aquatic environments near your school. Give their locations.

2. Where are good examples of north and south facing slopes found near your community?

3. Briefly describe the biotic communities found within 50 miles of your school (e.g., riverine environment, piñon-juniper community, grasslands, lake, pond, etc.).

ENDANGERED/EXTINCT SPECIES

1. What animals (prehistoric and/or modern) used to live in your community but are now extinct?

2. When did each extinction occur?

3. What species of endangered plants and animals are found in your community today?

4. What are the current threats to these endangered species?

5. What local or national efforts, if any, are underway to protect these species?

GENERAL INFORMATION

1. What is the elevation of your school?

2. What is the lowest elevation within 50 miles of your school?

3. What is the highest elevation within 50 miles of your school?

4. How much moisture (on average) does your area receive in one year?

5. During which months and in what form does the moisture occur?

6. List any local people or agencies that could serve as a resource for your science education program:

6. DEVELOPING CUSTOMIZED RESOURCE MANUALS

One of NMRSEP's most popular features is the manual we develop for each school or district with which we work. Although manuals for different districts may share some common materials, each is tailored to the individual science resources in a specific area. We have found resource manuals to be useful both in teacher education workshops and as an ongoing idea and reference source for teachers. In the resource manual, you will want to report field survey findings, provide background information on local natural resources, provide pictures and descriptions of local plants, animals, rocks and fossils, list local resource agencies, and provide sample learning activities and a resource bibliography for teachers. (One note of caution: Beware of reproducing copyrighted photographs, illustrations, or texts without permission! As an alternative, we suggest that you look for materials in the public domain, such as publications from state and federal agencies or federally funded programs such as this one. Properly reference all texts and write your own descriptions of natural features. Find staff or volunteers who can sketch needed illustrations, or use illustrations already belonging to the museum. Or ask permission to reproduce illustrations from locally published sources.)

Our manuals average about 60 pages in length. They are usually photocopied pages, stapled together, with an attractive cover page. Here is the format we follow:

1. Introduction to the area's natural resources.

2. Glossary of scientific terms used.

3. A section on maps pertinent to the region. We include a section on how to use topographical and geological maps that are useful in the area.

4. Description of regional rock layers, how they were formed, the natural resources they contain, how old they are, and the fossils they contain. We try to include pictures of sample fossils and life reconstructions.

5. Introduction to life zones of the region. An introduction to the biotic community (life zones) in which the school is located can help teachers understand the forces acting on the plants and animals to make them look and behave the way they do.

6. Plants of the region.

7. Animals common to the region.

8. Descriptions of hands-on activities that address local natural history, science resources, and science concepts and processes.

9. Listings of local and area resource people and agencies.

10. Bibliography.

The following sections offer ideas and suggestions for researching and presenting background information, and for developing learning activities to include in the manual.

Presenting information about local geology, paleontology, botany, and zoology

Your field survey trip will help define the universe of plants, wildlife, and other natural features to be described in the resource manual. Once you have completed the survey trip, the next step is to do some research and summarize what you learn in a form teachers can refer to quickly and easily.

Drawing on museum resources. What resources does your museum have that can help you with your research? Do you have a complete set of topographical or geological maps for the state? Do you have a library with geological and zoological publications? You probably will want to start a collection of maps and books appropriate to the regions in your state in which you are working. Curators will be able to help you find out what is available, useful, and scientifically accurate. You may be able to copy maps or sections of books from the curators' libraries. Curators can also suggest field guides appropriate to your area to purchase for use throughout the project. Museum exhibits may also contain information pertinent to the region you are studying.

Drawing on other resources. A nearby university might have appropriate scientific publications as well as a map room where you can copy maps. You may need to consult resource people such as university professors or personnel from state or federal agencies to research your survey's findings. In addition, here are some general books that we have found useful in our research:

Geology/Paleontology

- *Glossary of Geology*, Third Edition, Robert J. Bates and Julia A. Jackson, Editors, American Geological Institute, Alexandria, Virginia, 1987. This is an excellent geologic dictionary.
- *Vertebrate Paleontology and Evolution*, by Robert L. Carroll, W. H. Freeman and Company, New York, 1988. This is the foremost book on vertebrate paleontology available.
- The New Mexico Geological Society publishes a series of guidebooks with road logs. There may be similar publications for your state.
- *The Illustrated Encyclopedia of Dinosaurs*, by Dr. David Norman, Crescent Books, New York, 1985. This is an excellent and comprehensive book on dinosaurs.
- *Earth and Life Through Time*, by Stephen Stanley, W. H. Freeman and Company, New York, 1986.

- *Barnes and Noble Thesaurus of Geology*, by Alec Watt, Barnes and Noble Books, New York, 1982.
- *The Fossil Book: A Record of Prehistoric Life* , by Carroll Lane Fenton and Mildred Adams Fenton (1958), Revised and expanded by Patricia Vickers Rich, Thomas Hewitt Rich, and Mildred Adams Fenton (1989), Doubleday and Company, Garden City, New York. The illustrations in this book are very useful.

Zoology/Botany

- *Mammalian Osteology*, by B. Miles Gilbert, 1980, B. Miles Gilbert, Publisher, 709 Kearney, Laramie, Wyoming, 82070, Library of Congress No. 80-84455. This book is valuable because it contains life-size illustrations of skulls and other bones of animals for direct comparison with field specimens.
- Life zone map and book: *Desert Plants*, Volume 4, Numbers 1-4, 1982. Special Issue: Biotic Communities of the American Southwest -- United States and Mexico. David E. Brown, Editor. Published by the University of Arizona for the Boyce Thompson Southwestern Arboretum. Extra copies can be obtained from the Boyce Thompson Southwestern Arboretum, P.O. Box AB, Superior, Arizona, 85273.

To locate more books, consult:

- Geoscience Resources, a catalog you can order toll-free by calling (800) 742-2677 or writing Geoscience Resources, 2990 Anthony Road, Burlington, NC, 27215. This catalog contains geological specimens you can order, equipment, regional maps, and books. Teachers may find a copy of this catalog useful as well.
- The U.S. Geological Survey, 907 National Center, Reston, VA, 22092. Through the USGS you can obtain topographic maps and other information on geography and geology.
- The supplier catalogs listed in chapter 5 include book lists. The field guides listed in chapter 5 and the bibliography are also useful.

Summarizing background information. Obviously you will not be able to present information on every tree, mammal, insect, or geological formation in a particular area in your resource manual. We suggest the following guidelines for selecting material to include:

- Include information about things that have unusual scientific or community interest or significance; for example, a rare or endangered species or a major fossil find in the area. Cuba, New Mexico, one of NMRSEP's participating schools, is located in an area of faults and uplifts; many New Mexico rock layers are visible in the area. NMRSEP's resource manual for Cuba, then, focuses strongly on Cuba's geologic history.

- Include information about things that are most common in the area. To use Cuba as an example again, the Cuba resource manual's plant section highlights two types of pine, juniper, and fir -- the trees most common in this Mixed Conifer life zone.

- Include a balance of examples from different areas of natural science.

- Include information about the topics and specimens in which teachers have expressed the greatest interest, either informally or through your needs assessment activities.

- In addition to describing specific specimens or natural features, be sure to link that information to science processes and concepts. When possible, also link the information to suggested learning activities.

The following pages present samples of background material developed by NMRSEP staff.

Developing learning activities that teachers can use

Learning activities are the most critical component of the resource manual because they, more than anything else, determine whether teachers actually use your materials. Learning activities also convey your approach to scientific inquiry and to science instruction; they provide a model for teachers to use as they search for activities from other sources or create their own. The instructional activities you present need to possess the following characteristics:

- They need to teach something of consequence. NMRSEP looks for activities that convey science content -- facts and concepts -- and also build students' skills in thinking and reasoning.

- They need to be linked to the school's science curriculum and goals for science education.

- They need to motivate students to explore and learn. This means that they integrate multiple learning styles (visual, auditory, tactile or using touch, and kinesthetic or using movement), engage students as active participants, and offer opportunities for all students to experience success.

- They need to convey the understanding that science does in fact relate to our day-to-day lives, by incorporating local natural resources and applying knowledge to processes and situations related to students' lives.

- They need to be appropriate to the developmental levels of students.

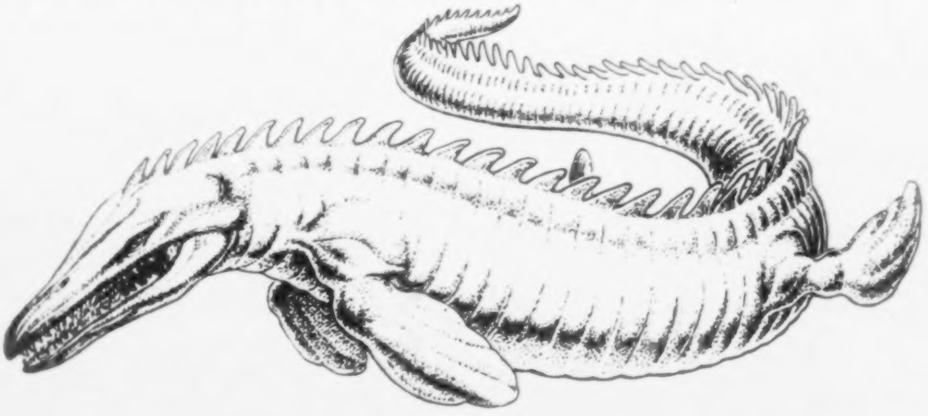
- They need to be "do-able" by teachers -- that is, they need to be manageable in terms of cost, effort, logistics, and the required curriculum.

Sample Pages from Geology Section of a Resource Manual for the Dulce, New Mexico, School District

Lewis Shale

The Lewis Shale is the major, base component of the mesas and valley floor in Dulce. It is composed of dark-gray to greenish-gray shale (marine muds) with some sandy layers, limestone, and orange limestone nodules. It was deposited about 74-70 million years ago, offshore in the departing seaway that covered northwestern New Mexico and southwestern Colorado. Rivers carried sediment to the sea, dropping the heavier sand grains close to the shore, depositing the Pictured Cliffs Sandstone that overlies the Lewis Shale. The finer sediment was carried further and deposited as the marine muds that became the Lewis Shale. The sandstone overlies the shale because, as the sea retreated, the shore moved back over what had once been the sea, covering the sea deposits with sand.

The fauna of the Lewis Shale consisted mostly of marine bivalves (including a giant clam called *Inoceramus*), gastropods, and cephalopods (see glossary). Worm burrows, shark teeth, and bony fish scales have also been found in this formation. The fossilized skeletal remains of a mosasaur, a giant marine lizard, were recently discovered in the Lewis Shale formation near Dulce by members of the Jicarilla Apache tribe.



MOSASAUR

The Dulce Mosasaur

The Dulce mosasaur was probably deposited in an offshore environment of relatively deep and quiet water where waves could not disturb the body. Fossil shell fragments, shark teeth, and bony fish scales were found around some of the vertebrae. These could have simply been deposited in the sediment, or they could have been the gut contents of the mosasaur. Mosasaurs were the "terror" of the sea. Fossilized stomach contents of mosasaurs and other giant sea reptiles have included pieces of shark, fish, ammonoids, birds, pterosaurs (flying reptiles), and even other mosasaurs!

The Mosasaur as a Lesson in Adaptation

Mosasaurs descended from terrestrial (land-living) lizards. During the transition from land to sea, the lizard body form evolved into a fish-like form. The feet became flippers with which the animal steered, and the tail developed flaps to assist in propelling the mosasaur as it flexed its body from side to side. The mosasaur remained an air-breather. Similarly, air-breathing whales evolved from terrestrial mammals that lived near the Dulce area 60 million years ago. Their four-legged ancestral body form also evolved into a fish-like form in adapting to a sea environment. This type of adaptation is called convergent evolution, where two animals from unrelated species come to resemble each other because they have adapted to similar environments.

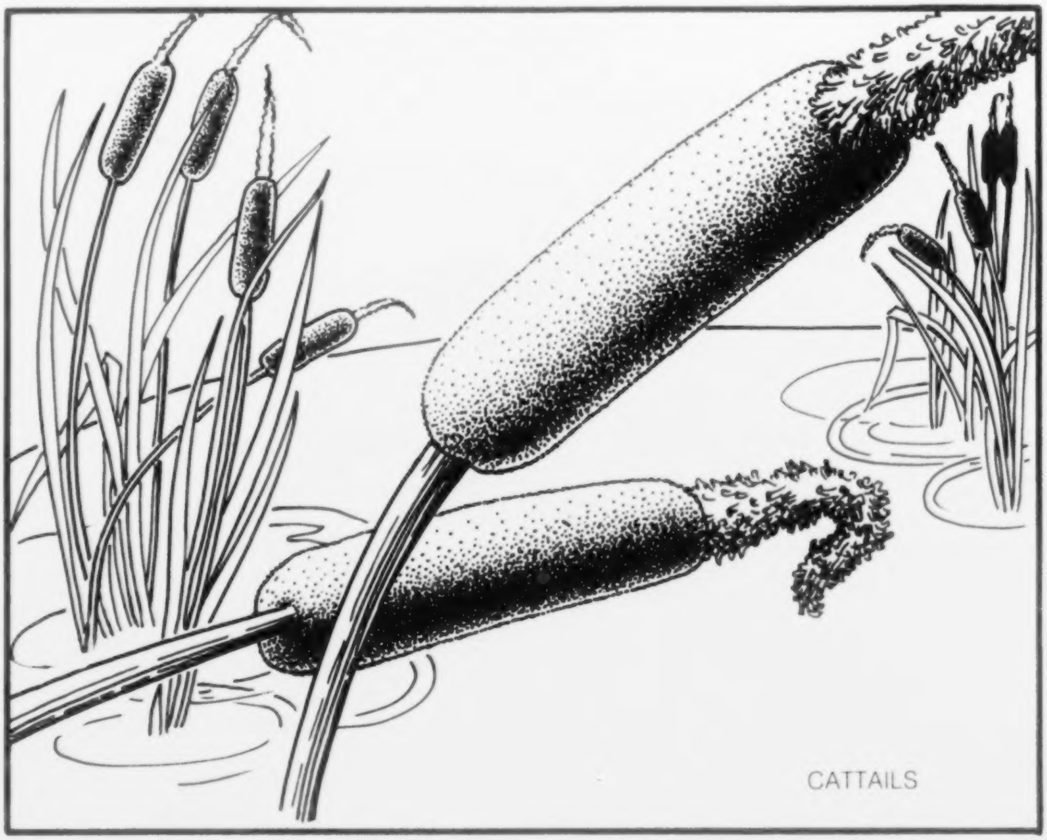
Watch a lizard walk. Note how it flexes its body from side to side to move. Look at the picture of a mosasaur, and compare it to a picture of a whale and a fish. In what ways does the mosasaur resemble the lizard, whale, and fish?

Sample Page from Botany Section of a Resource Manual for the Dulce, New Mexico, School District

Cattail

(Typha latifolia)

The common cattail is probably one of the most easily identified and useful plants found in or near water. One of the most distinguishing characteristics of this plant is the thick "cattail," which is actually the plant's cluster of flowers. The cattail's flowers are divided into two portions on the stem: the top, thinner male portion and the thick, wooly "hot dog on a stick"-looking female flowers. After the male flowers have released all their pollen, they fall off leaving an exposed spike over the female flowers. The seeds are wind distributed. Nearly all parts of this plant can be used; the female flowers are an excellent insulator and can be used as tinder to start a fire. In the event of an emergency, the roots and new shoots are high in starch and can be eaten raw or cooked. Animals use the cattail not only as food but also for shelter and for nesting material. In the past, the leaves provided material for weaving.



CATTAILS

Using the Cattail as a Lesson in Symbiosis

Elements of any ecological system live in an intricate web of interdependence. When two species of organisms live in close physical contact with each other, their relationship is called "symbiotic." There are three major forms of symbiotic relationships:

- **Commensalism** - A relationship in which one species derives food or shelter from another species without seriously harming that organism or providing any benefits in return.
- **Mutualism** - A reciprocal symbiotic relationship in which both species benefit and are dependent upon the relationship.
- **Parasitism** - A relationship between two species in which one species (the parasite) nourishes itself to the detriment of the other species (the host).

In the Dulce area, yellow-headed blackbirds are often seen on the tops of the cattails around the lakes. These birds build their nests between the stems of the cattails, several feet above the water. This way, they are protected from predators that will not venture into the water. Which category of symbiosis might this relationship fall under: parasitism, mutualism, or commensalism? Consider the fact that the bird's dung fertilizes the cattails. Does that change your selection? The cattail and the yellow-headed blackbird would be a good pair for the "Symbiosis Game" that is included in the "Activities for Dulce" section of this resource manual.

The following sections offer suggestions to help you plan, develop, and adapt learning activities.

Addressing state and local curriculum requirements. It is important to familiarize yourself with state mandates and guidelines for science education. In New Mexico, for example, the State Department of Education, at the direction of the legislature, has identified "essential competencies" for each school subject to be addressed by the local curriculum. Science competencies focus on 13 process skills that must be taught in conjunction with science content for grades 1 through 8. These skills are: observing, classifying, predicting, measuring, communicating, inferring, interpreting data, making operational definitions, formulating questions and hypotheses, experimenting, modeling, using quantitative applications, and recognizing impacts. All learning activities suggested to teachers by NMRSEP incorporate one or more of these process skills. Contact your state department of education to ask for a listing of all state-mandated requirements for elementary science instruction.

Also talk with your school contact person about any additional local curriculum requirements. Review local textbooks and supplementary materials, noticing the scope and sequence of material; plan activities that fit logically into this instructional sequence. At times, a small change in a textbook activity that relates it to a concrete, local example or specimen can make all the difference in capturing students' interest and assuring that they will remember the scientific principle being taught.

Addressing science concepts, processes, and thinking skills. As noted in chapter 1, effective science instruction involves a balanced focus on three elements: specific facts, more general science concepts, and students' skills in processing and applying facts and concepts. Traditionally, science teaching has tended to emphasize the memorization of facts without providing students either the skills to use them or a real understanding of their relevance to students' lives. In recent years, the pendulum has on occasion shifted too far in the other direction, with learning materials and innovative science curricula neglecting the facts that give substance to processes, issues, and problem-solving skills. Good teaching addresses all three elements. Not every single learning activity needs to give equal weight to all three, but overall both the activities you suggest to teachers and the instructional philosophy you model for them need to reflect such a balance.

Using hands-on approaches. Especially in science, interactive, experientially-based learning has been proven to be most effective. Most people who are only lectured to will find a subject hard to understand. When a child participates in a lesson, more than one sense is involved, allowing a concept to be assimilated through more than one channel. Also, for most people, learning a new concept from a familiar (concrete) frame of reference helps greatly in its acquisition. From this reference point, a more abstract level of understanding can then be reached.

A child can participate in learning in many different ways. Some students are more visually oriented; others are better at understanding concepts if they have something to manipulate. Techniques for active participation can be as simple as asking students to touch their spines to prove they are vertebrates or to define an unfamiliar word from a word that is clearly understood. As an example, trying to have students remember the definition of the word "aquatic" can be approached from two different angles. The definition could be given outright: Aquatic means living in water. Or, Spanish-speaking students could be asked to name the Spanish word for water (agua) and to notice its similarity to "aquatic." Moving from agua to aqua to aquatic, bases a definition of a new word on a familiar word and engages students in the discovery process. When a student is allowed to make a discovery, the reward is a sense of accomplishment. This is one of the best tools for reinforcing the contents of a lesson.

A museum can be a wonderful resource for schools by providing high quality teaching specimens of minerals, zoological or botanical materials, and fossils. A child who is allowed to see, touch, and explore a specimen is more likely to remember its significance and that of its associated concepts than if she or he is only exposed to an illustration or photograph.

Live animals are always the center of attention in any classroom. A great deal can be learned about their behavior and anatomy through careful observation. Counting the legs on a spider is more fun than being told how many legs it has. Keeping records and graphs as to when an animal is active, when it eats, and what foods it prefers can easily become a class project. Live animals can also provide a tie-in to other subjects such as mathematics, art, and the language arts.

Art and language arts, as well as mathematics, can fit very well into a hands-on science curriculum. Much of science is tied into observation of the world around us; art can be a way of recording those observations. Through the use of art, and with proper coaching and encouragement, a child can develop a keener sense of observation. Language arts can also be integrated into a science curriculum; asking children to write a poem, compose a song, or role play a science concept not only reinforces the lesson, but can also be fun.

Newspaper articles on relevant topics or local science events make excellent reading comprehension and critical thinking activities that further a child's understanding of science and its relevance. They can also be a jumping off point for a class discussion on a science topic.

Using developmentally appropriate language and concepts. Learning activities, and the science concepts they address, need to be geared to students' levels of development and experience. However, we urge you not to be rigid in your ideas about what is appropriate for a given age group. We have often been surprised to find our assumptions about the abilities of children at different age levels overturned through experience. Age is not the only developmental factor to consider, as experience can prepare a child for understanding higher-level concepts. We are often surprised with children's abilities to go beyond our expectations of them. At other times, we have had to simplify activities that worked well with one group of students, to suit them to another group of the same age.

Remember that flexibility is essential in working with children. Rural children enter school with a great deal of informal knowledge about nature and natural processes. It is possible to use this knowledge and experience as a basis for teaching science concepts and process skills, even to very young children. Because dinosaurs are so fascinating to children, and there are so many fossils in New Mexico, many children in New Mexico are very curious about fossils and have a general understanding of what a fossil is and what the word "prehistory" means. Many young children understand that dinosaurs lived before there were people. They are fascinated by dinosaurs and know the names of many prehistoric creatures.

It is important when discussing advanced concepts with children to use the simplest terminology possible. For example, if a school is surrounded by Cretaceous marine sediments, you might explain that the sandstone is from the shore of a sea which covered the area during the end of the Age of Dinosaurs. Children may not be able to grasp what "63 million years ago" means, but they can understand sequences of events and begin to put together pieces of the concept of evolution and geologic time. Children can begin to understand many higher-level concepts when they are described with simple vocabulary. One second grader carried on a very logical, informed discussion with staff about the dinosaur extinctions. A fifth grader correctly identified a partial skeletal"Prehistory Mystery" as a "hadrosaur," when many adults do not even know that the word hadrosaur means duck-billed dinosaur.

Sources for activity ideas. Following is a list of sources for ideas for hands-on activities that can be adapted to focus on local natural resources:

- OBIS, Outdoor Biology Instructional Strategies, Lawrence Hall of Science, University of California, Berkeley, California, Delta Education, Inc., Nashua, New Hampshire, 1980. Emphasizes interaction of organisms with each other and their environments, including interaction of people with the environment. Strategies used include games, simulations, craft activities, role playing, experiments, and data analysis. The activities are designed for 10-15 year-old youngsters; there are 97 activities, organized into different modules. Obis Resource Center Directory is available at no charge from the OBIS project or the publisher, Delta Education, Inc., Box M, Nashua, NH, 03061-6012, (606) 889-8899. An OBIS Sampler is available from Delta Education, Inc. for $6.80.

- Project Wild, Salina Star Route, Boulder, CO, 80302. The principal sponsors of Project Wild are the Western Association of Fish and Wildlife Agencies and the Western Regional Environmental Education Council. It is an environmental and conservation education program for teachers of kindergarten through high school age students. There are elementary, secondary, and aquatic activity guides. Instructional activities are designed for easy integration into school subject and skill areas -- especially science, social studies, language arts, mathematics, and art. See especially the Project Wild Elementary Activity Guide, copyright 1983 by the Western Regional Environmental Education Council.

- Project Learning Tree, American Forest Council, 1250 Connecticut Avenue, N.W., Washington, D.C., 20036. An environmental education program designed for kindergarten through grade 12 teachers, Project Learning Tree is a source of excellent interdisciplinary activities and provides workshops and inservice programs for educators. Over 175 activities help teach science, mathematics, language arts, social studies, humanities, and other subjects.

- *A Field Guide to the Atmosphere,* by Vincent J. Schaefer, Houghton Mifflin Co., 1981. This guide contains background material on weather phenomena and an excellent chapter describing many weather experiments and activities. You can adapt these to the weather phenomena experienced in your locality.

- *The Everyday Science Sourcebook,* by Lawrence F. Lowery, Allyn and Bacon, 1978.

- *Outdoor Areas as Learning Laboratories: CESI Sourcebook,* compiled and edited by Alan J. McCormick, ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Ohio State University, College of Education, 1200 Chambers Road, Third Floor, Columbus, OH, 43212. *Ranger Rick's Naturescope,* published by the National Wildlife Federation, 1400 Sixteenth Street, N.W., Washington, DC, 20036-2266. These books are excellent sources of information and activities on natural science subjects.

- *The Evolution Book,* and *The Science Book,* by Sara Stern, Workman Publishing, N.Y., 1986 and 1979. These guides contain a number of easy-to-do activities.

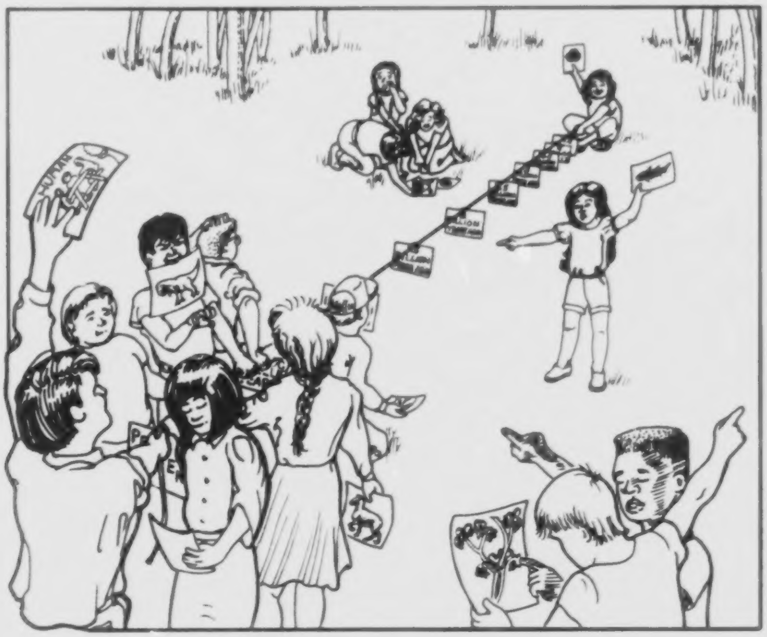
- Publisher's guides to textbooks and teacher's guides often include relevant activities.

NOTE: Appendix B includes a more extended bibliography of books that contain background information or suggested learning activities that may be useful to you or to teachers.

Adapting existing activities. Often you will find an activity that demonstrates a concept very well but has to be adapted to local conditions to get the desired results. Following are some examples of activities that we had to adapt to a local context.

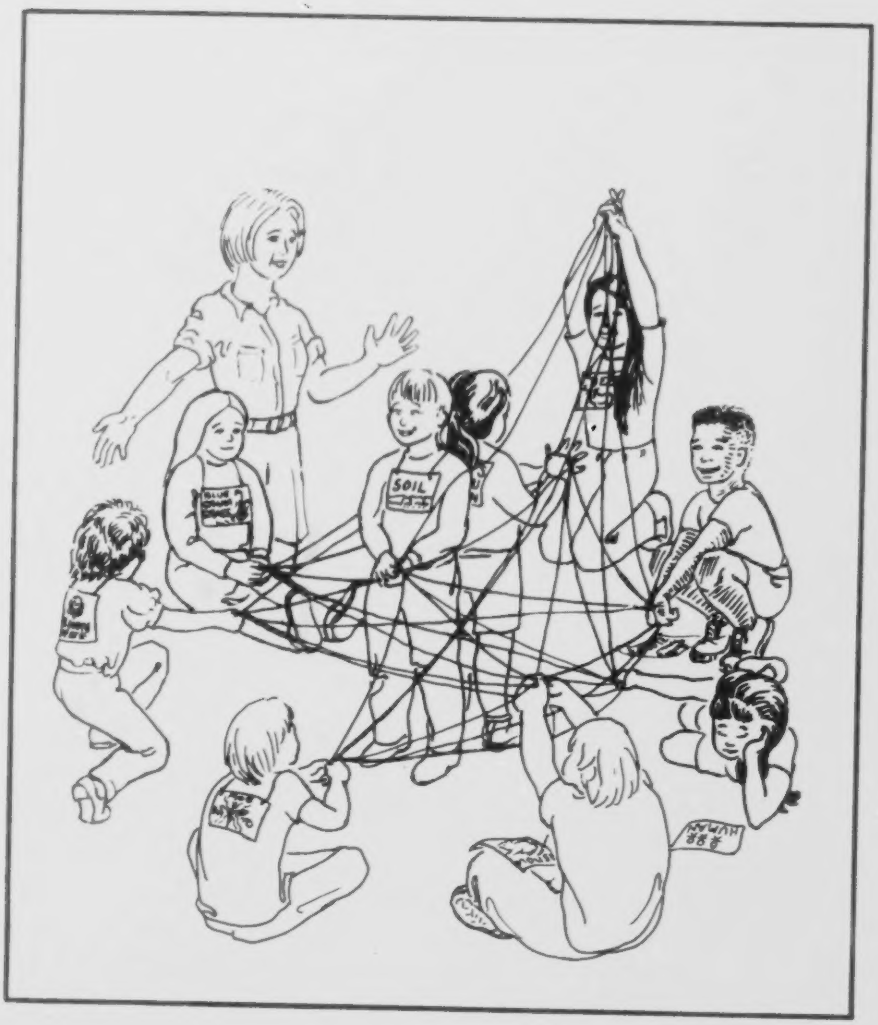
> **Timeline.** (Adapted from *Ranger Rick's Nature Scope,* "Digging into Dinosaurs," 1984.) This activity helps students understand the scale of geologic time and puts prehistoric animals and humans into geologic context. To do this activity, a rope 100 feet long is stretched out. The students are told that the rope represents the 4.6 billion years of earth history, with one end representing today and the other end when the Earth formed, 4.6 billion years ago. Students then are given a picture of a fossil plant, animal, or geologic feature and are asked to place themselves along the line where they think the specimen belongs. After they have placed themselves, they are told the actual place where they belong on the line. (Students are usually surprised to find that most advanced life forms are crowded at the end of the rope.) When we use local geological and paleontological examples, rather than pictures, we find that students are more interested in the activity than if they are

given a picture of some distant place. As an example, in Dulce, New Mexico, the remains of a Cretaceous marine lizard called a mosasaur were found. The Dulce mosasaur became very exciting to the children when they learned that this animal lived right in their backyard and that local people found it, not paleontologists or geologists.



Hungry Raccoon. An activity that NMRSEP adapted to accommodate local cultural traditions was the game "How Many Bears Can Live in This Forest?" from Project Wild. Bears are held sacred among the Navajo people; in several NMRSEP schools, to have the children pretend they were bears would violate local customs, so we changed the animal to raccoons, which are omnivorous like bears and are common in northern New Mexico. To do the activity, cards with food values are tossed freely into the wind (i.e., around the classroom). The "raccoons" must collect and return to their den with enough food cards for survival. If a raccoon fails to collect enough cards either it dies or its cubs die.

Food Web. (Adapted from "Web of Life," Project Learning Tree, Activity Guide K-6.) The Food Web activity shows students the interdependence of living organisms in a given area. Students are each given a card with the illustration of an organism that lives in their community and are asked to form a large circle. The leader or teacher discusses and visually shows the relationships among the various organisms, connecting them using a ball of yarn or string. When the web is complete children have a better concept and understanding of the interdependence of life. This activity can be adapted for any ecosystem or life zone, e.g., coral reef, desert, or piñon/juniper forest.



Developing your own learning activities. Activities that demonstrate a very specific concept often will have to be developed by project staff. The idea may come from a situation you encounter or a suggestion from a teacher or even a student. On the following pages are some sample activities we developed that have been popular with teachers and students alike. Each activity was developed to address the needs and environment of a particular school; however, we have been able to adapt them for use in different contexts.

Sample Activity
Making a Dichotomous Key

Activity: Make a dichotomous key using leaves collected locally from broad leaved trees.

Grade Levels: 4-6

Process Skills: Observing, classifying

Materials Needed: Leaves collected locally, paper, pencils

Objectives: Students will classify leaves based on similarities and differences and will construct and learn how to use a dichotomous key.

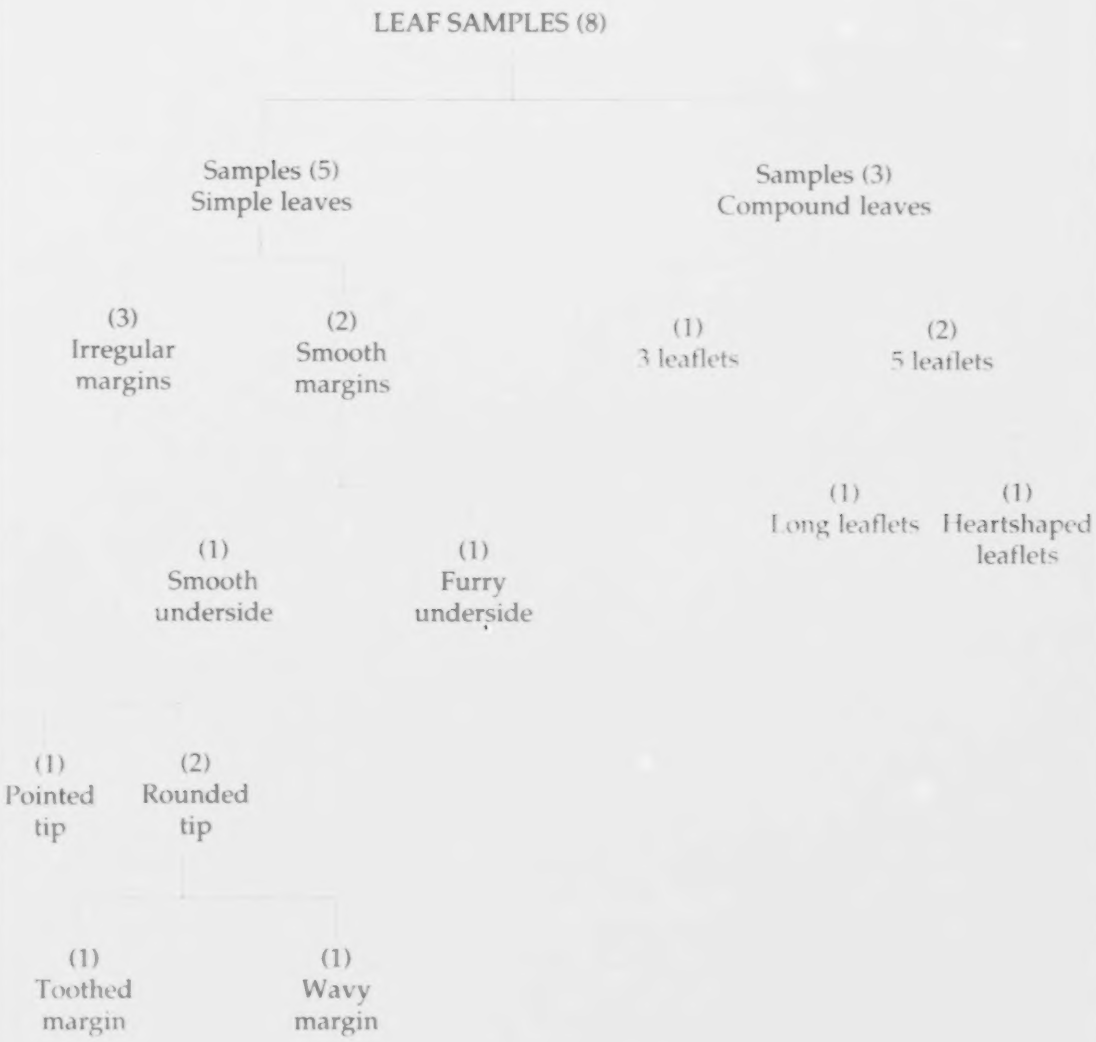
Background Information: Many tools are used in science to help classify animals, plants, minerals, and many other things in our environment. One of the most important tools is the dichotomous key, which is a method for classifying things by sorting them into two categories, then continuing to sort each category until only one item remains in each category. (See the example on the following page.)

Procedures:

1. Divide the class into small groups.
2. At home, around the school yard, or on a field trip, have each group collect eight *different* kinds of leaves from deciduous trees -- i.e., those that lose their leaves in the fall. *(NOTE: To simplify this activity, we do not use evergreen needles.)*
3. Have each group study their selection of leaves, noting their characteristics, differences, and similarities. (It is not important for the purposes of the activity to know the name of the tree from which the leaves were taken.)
4. Have each group sort their leaves into two piles, using one major category of difference or similarity as the criterion for sorting the leaves. (You may have to prompt students as to likely categories for sorting.) Have them write down their criterion.
5. Have students continue to divide their piles of leaves by twos according to categories of similarity or difference until only one leaf (or no leaves) remains in each category; have them write down their criteria for each sort.
6. Show students the format for a dichotomous key and have them draw one using their notes.

7. Options for expanding this activity include having students use the key to find the trees that the leaves came from, working backwards through the key; having them demonstrate their ability to use the key by adding new specimens; discussing the differences and similarities between the keys developed by different student groups; and using the key with groups of seeds, teeth, rocks, or fossils.

Example of a Dichotomous Key


LEAF SAMPLES (8)
Samples (5) Simple leaves
Samples (3) Compound leaves
(3) Irregular margins
(2) Smooth margins
(1) 3 leaflets
(2) 5 leaflets
(1) Long leaflets
(1) Heartshaped leaflets
(1) Smooth underside
(1) Furry underside
(1) Pointed tip
(2) Rounded tip
(1) Toothed margin
(1) Wavy margin

Sample Activity
Microhabitats

Activity: Study a small outdoor area for a week or more, to observe its characteristics and changes.

Grade Levels: 3-6

Process Skills: Observing, predicting, measuring, formulating questions

Materials Needed: Stakes and string for marking off an area to observe (one set per student), meter sticks for measuring the area, pencil and paper for drawing a map and for recording observations. Optional: hand lenses for close observation, thermometers for measuring air and soil temperature, soil test kits for determining the pH of soil.

Objectives: Students will measure an area to observe, observe the conditions and characteristics of a microhabitat, record their observations, and make logical predictions about further possible changes in the microhabitat.

Background Information: Many things happen in nature, on a small scale, that may be missed unless special efforts are made to observe them. In some microhabitats you may observe food webs, predator-prey relationships, evidence of outside disturbances, and the like.

Procedures:

NOTE: This activity requires that students have access to an area in or near the school yard where they can stake out a small plot of ground that will remain undisturbed for an extended period of time -- one week at a minimum, and preferably at least a month. There are also many options for conducting this activity, based on your constraints and preferences. Each student may have her or his own plot, or students may work in small groups. You may have students observe the microhabitat at different times during the school day, or at the same time over an extended period. You can have students focus on a great variety of things, such as soil conditions, plant life, insect habitats and activity, animal tracks, or weather and moisture conditions. You can have older students plot their measurements and observations on graphs; you can use the plots as a basis for art or language arts activities, such as drawing a picture or telling a story based on something found in the microhabitat.

1. Have each student or group of students choose and mark off, using a meter stick, stakes, and string, a one square meter area to study.

2. Have students draw a detailed map of their plot, indicating everything that is within the area -- rocks, grass, plants, spider webs, anthills, etc.

3. Note any specific observations or measurements you want students to make, such as soil or air temperature, moisture, number of different plants or insects on the plot, etc.

4. Have students continue to observe their plots and record their observations.

The following are some suggestions for recording conditions and changes:

General weather record -- date and time, general weather conditions, air temperature at soil surface, air temperature three feet above the soil, moisture conditions

Record of soil conditions -- pH of soil, texture and consistency of soil, date and time of periodic observations, moisture, temperature in the sun, temperature in the shade

Have any new plants appeared on your plot? If so, what are they and how many are there? Are they the same as or different from plants already in the plot?

Describe any evidence of animal or insect activity.

Examine the plot with a hand lens. Observe any animals you find; count the legs and try to determine whether they are insects, spiders, larvae, or worms. Where did you find these specimens -- on the plants above the soil, on the surface of the soil, or in the soil?

Compare your plot with other plots. Does it have more or fewer plants? more or fewer insects? Does it get more or less sun than other plots? Are there other ways in which it is especially different from other plots? Were the living things exactly the same on any two plots of ground?

Compare the plot that has the smallest number of new plants with the other plots. Is the soil there different from the soil in most of the other plots? Does it get more or less water or sun than the others?

Sample Activity
Prehistory Mystery

Activity: Infer what a prehistoric animal looked like in life given a picture of its skeleton.

Grade Levels: 1-6

Process Skills: Inferring, communicating

Materials Needed: Copies of a drawing of the skeleton or portions of the skeleton of an unfamiliar fossil animal; drawing materials.

Objectives: Students will draw logical conclusions or interpretations as to the fleshed-out appearance of an unknown fossil animal, given a picture of the prehistoric animal's full or partial skeleton, and will communicate the inference graphically through a drawing.

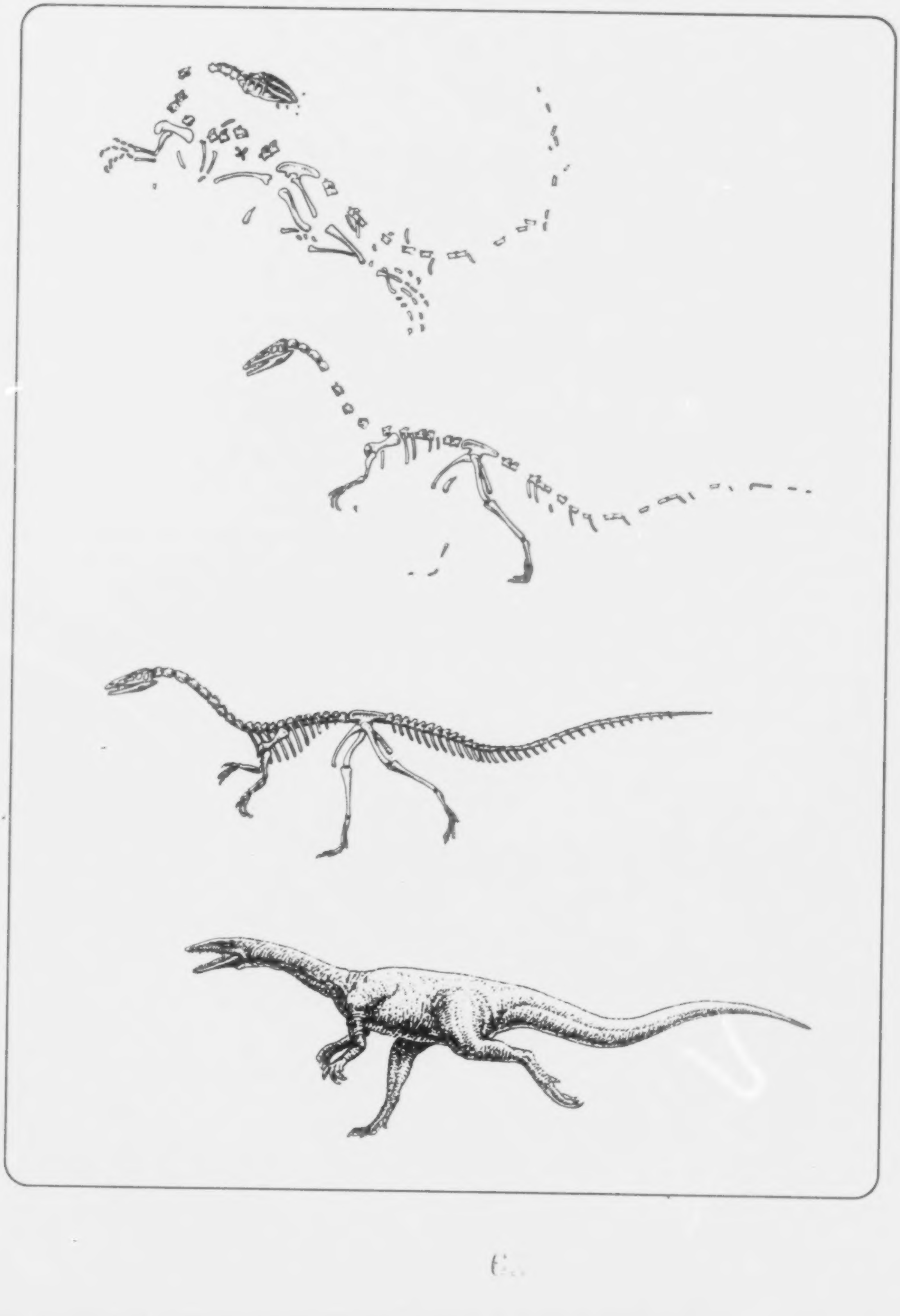
Background Information: Scientists use inference to decide what fossil animals looked like in life. Their reconstructions are based on the animal's skeleton, footprints, and skin impressions, and on comparisons with modern animals. Artists reconstruct fossil animals through a process of placing muscles on the bones, then layering appropriate skin texture over the muscles.

Procedures:

1. Provide students with a drawing of the skeleton of an unfamiliar prehistoric animal. (For younger students, you will need to provide a drawing of the full skeleton; for older students, "white out" some of the bones so that students have to make additional inferences about what is missing. See the sample illustrations on the following pages.)

2. Ask students to draw what they think the animal actually looked like in life.

3. Ask the students how they arrived at their picture. What inferences did they make about the animal's size and appearance? Could they tell whether the animal was a fish, amphibian, reptile, bird, or mammal? How?



Chelsea Robbins age9

Sample Activity
Fossil Dig

Activity: Students will uncover fossils, represent the dig graphically, and infer the ancient environment in which the fossil animals and plants lived.

Grade Levels: 3-6

Process Skills: Communicating, inferring

Materials Needed: Paper, paintbrushes (2-3"), compasses, crayons, fossils or casts of marine animals and terrestrial animals, string, and stakes

Objectives: Students will record observations in the form of pictures and maps, and will make logical inferences based on these observations.

Background Information: A fossil should never be removed from its original place in a rock layer without mapping and documenting where it was found. To properly date a fossil within its geologic age, information about the exact locality where it was found is essential. Fossils of worldwide scientific significance are continually being found in New Mexico, often by members of the general public, and it is important to teach children about proper fossil collecting procedures and ethics.

Procedures:

1. In a sandy place or sand box, stake off several large rectangular areas (one for every 5-6 children), by driving a stake at each corner and roping the stakes off.

2. Bury either marine or land fossils that can be or have been found in your local area in each rectangle (put only marine or only land fossils in each rectangle). If you do not have access to real fossils, you can use casts. The fossils or casts should be large enough that they are not easily lost when buried. Possible marine fossils may include shells (brachiopods or ammonites), crinoids, corals, shark teeth, or trilobites. Terrestrial fossils may include wood, bones, coprolites (fossilized dung), and footprints.

3. Before beginning the activity, divide your students into groups of five or six. Give each group a piece of paper that represents their fossil square, a compass to find north, south, east, and west, and crayons to map their fossils.

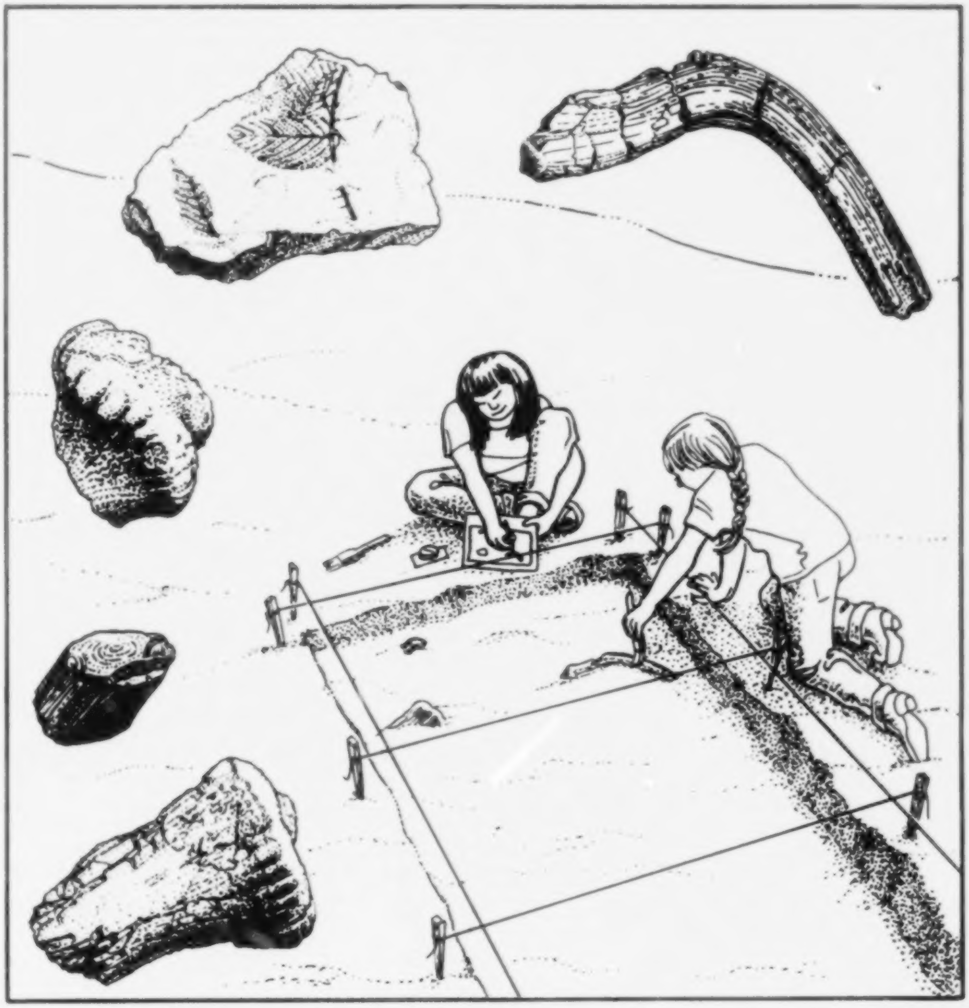
4. Demonstrate for your students how to use a brush to uncover fossils without damaging or moving them. Explain that scientists use brushes because fossils are so fragile.

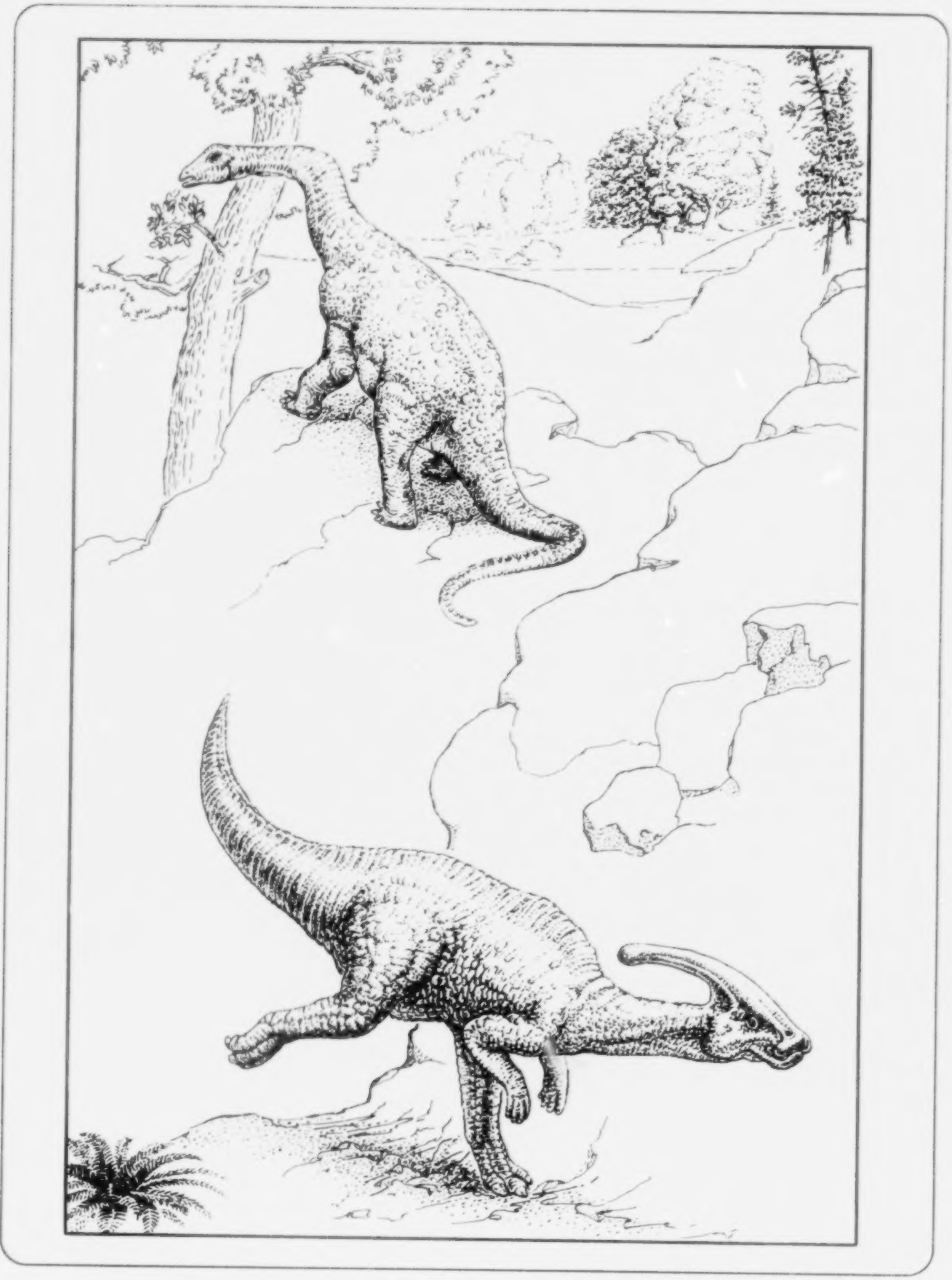
5. Station each group at a fossil rectangle. Have them determine north, south, east, and west in relation to their rectangle and indicate those directions on their "map."

6. Give each child a brush for uncovering fossils. Warn students not to pick up any fossil they find, because their maps will be incorrect if a fossil has been moved.

7. Whenever students find a fossil, have them draw the fossil in its proper location on the map and place their initials next to it.

8. After students have completed the fossil dig and their maps, have each group infer the ancient environment for the fossils in their rectangle (land or sea). Ask them what they might have inferred if they had found both sea and land fossils in the same rectangle (e.g., there may be freshwater fish and shells together with leaves or animals that fell into the water; a land-living animal's skeleton or a tree trunk could have been carried by a river into the sea, etc.).





Sample Activity
Time in a Bottle

Activity: Create a model of the rock layers in your community.

Grade Levels: 3-6

Process Skills: Observing, communicating, measuring

Materials Needed: Glass vials, jars or test tubes with screw-on tops and foam rubber to seal, sand from different rock layers, glue, 3x5 cards, a key or geologic map to the rock layers in your area

Objectives: Students will observe the layers of local rock and communicate their observations by creating models of the local strata.

Background Information: Many of New Mexico's rock layers or strata are formed from layers of sand, silt, or clay particles deposited by rivers, wind, or bodies of water. With time, these deposits become rock layers. The rock is called sedimentary rock; the oldest layers are those at the bottom, the youngest at the top.

Procedures:

1. Have the students observe a layered mesa, mountainside, or roadcut and collect sand from each layer. Have them note on each jar of sand what layer it came from (e.g., fifth from the bottom) and about how thick the layer was. When the sediments are collected, try to scrape them off the surface because the sand underneath may be a duller or different color. Also try separating different colors from layers within the same formation, so that you can represent several color layers for a multi-layered formation.

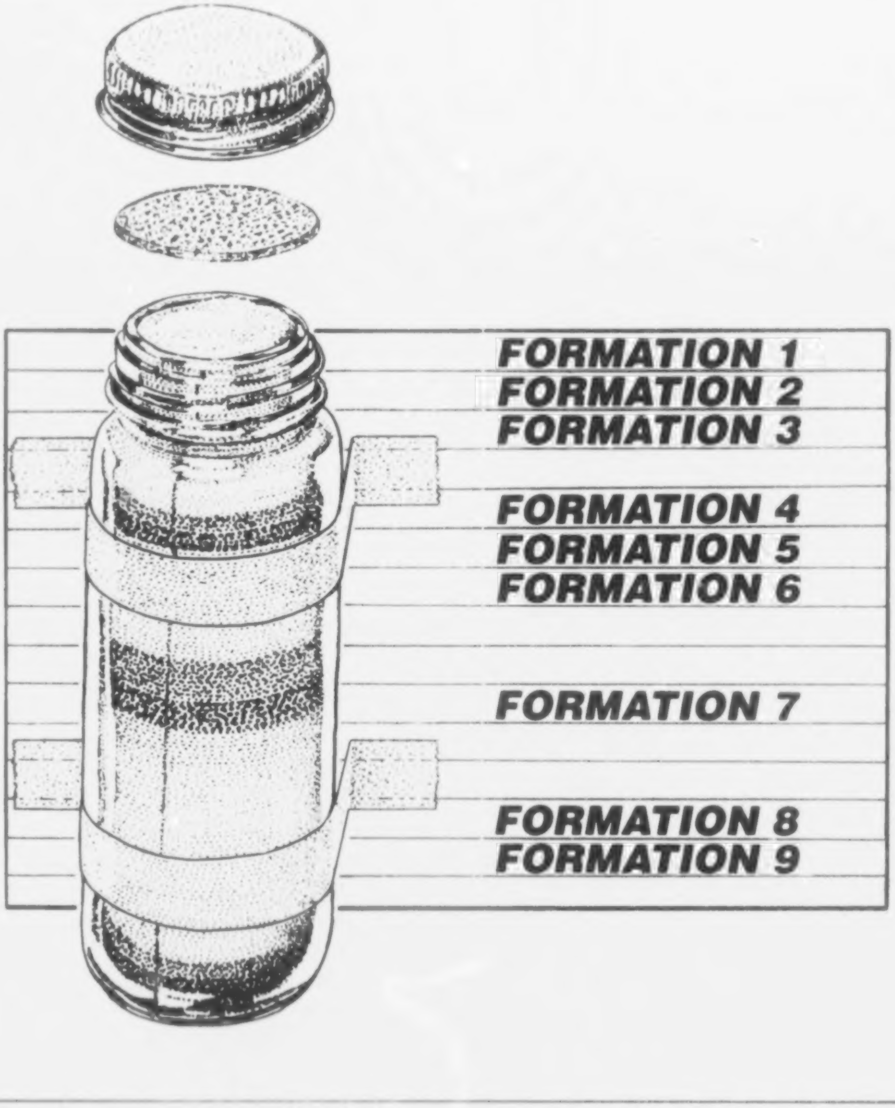
2. Obtain glass containers (small, thin vials work well). Have students layer sand, silt, gypsum, coal, etc. from geological layers in the correct sequence bottom to top inside the vials. This will work best if the sand is crushed to the finest powder possible. Also have them try to reflect the proportionate thickness of each layer. (For older students, measuring the actual thickness of each rock layer and determining the correct proportions can make an excellent, integrated math-science lesson.)

3. Cap the vial tightly with the thin piece of foam rubber or other expandable material at the top of the sand to keep it packed.

4. Have students make a key on a 3x5 card to go next to the vial, labeling each layer according to the geologic period. (Again, this lesson can be made more challenging for older students by having them identify the different rock layers.) You could also tape the vial to the card and label the card around the vial.

5. To expand this activity, you might have students make faults or dikes within their bottles. (For these activities, baby food jars work better than vials.) If you place a straw inside the jar, fill the straw with a contrasting color of sand, and then layer around the straw, when you pull the straw out you will have made a dike. You can make a diagonal plane out of thin cardboard and layer on each side of it, with one side's layers being shifted upward in relation to those on the other side. Extra layers would be added to the bottom of the higher sequence, and the top of the lower sequence. This configuration would represent a fault.

6. An alternative activity is to use sand from each layer to create a sand painting of the mountain or mesa.


FORMATION 1
FORMATION 2
FORMATION 3
FORMATION 4
FORMATION 5
FORMATION 6
FORMATION 7
FORMATION 8
FORMATION 9

7. DEVELOPING OTHER SUPPORTING RESOURCES

Developing specimen collections for your program's use

Why is another collection, in addition to the permanent science collection, needed for an education department? Specimen collections serve as a resource and are an essential component of any demonstration for a rural education project. They can be used as loan material to teachers, as hands-on materials for students, as a comparative collection for the public, and for local as well as outreach presentations by the education staff.

How to establish a collection. A number of sources can be used to create your program's collection, including your own finds on field survey trips, donations from teachers, students, or the public, and other divisions within the museum. Never feel, however, that a donated specimen must be accepted into your collections. Specimens that are of low quality and that may cause confusion when used for teaching should not be accepted. Do not make the task of figuring out how to discard low quality specimens yours. At the New Mexico Museum of Natural History, official policy requires us to refer all potential donors to a curator, who screens specimens as to their appropriateness for donation to the museum's collections. This policy relieves us of responsibility for accepting or rejecting specimens of poor quality or dubious origin.

Specimens that could potentially be donated to your museum's collections can be rated on the following scale; categories 2-4 represent the specimens that are likely prospects for your collection:

1. **Discard.** Quality is too poor for any purpose.
2. **Giveaway.** Specimens that are of insufficient quality for the museum's education collection, but that a teacher may be able to use effectively with students.
3. **Teaching.** A very good example of a specimen that does not exhibit any ambiguities as to its identity.
4. **Exhibit.** A well documented specimen of exceptional quality or rarity.

One of the major contributors to our collection is the museum's main science collection. Most science collections have specimens that are poorly documented as to the location of their discovery, are not of sufficient quality for their purposes, or are not needed because the museum has a large number of duplicates. Any of these are excellent candidates for an educational collection; specimens obtained in this manner are often of very good quality.

Many institutions are equipped to make casts of fossil material. The curator of paleontology at our museum knows that if he is going to cast any fossil specimens, he should also cast some for our collections. In this way, we obtain excellent casts of rare or even one-of-a-kind specimens.

You may also collect many of your own fossil specimens during field surveys or other outings. However, do not collect any specimens until you have a thorough knowledge of local, state, and federal laws. The curator of geology or paleontology at your institution should be aware of most applicable laws and regulations. Most institutions have an ethics statement regulating collection by its staff that addresses federal and local laws.

While invertebrate fossils are not normally protected by state or federal laws, fossil vertebrates found on federal property are strictly protected. To collect on federal Bureau of Land Management (BLM) lands, no permission is needed to collect fossil plants or invertebrates. However, the limit on the amount of petrified wood a person can collect is 250 pounds per year. To collect on Forest Service lands, contact the District Ranger. In national parks or monuments, contact individual Park or Monument managers. State laws protecting invertebrate and vertebrate fossils vary, so check with the State Land Office before collecting on any state lands. Most state lands, except for parks, are off limits to the public. Fossils found on private land are not protected, but permission to collect by the owner must be obtained.

Any time an individual or institution wishes to collect on Indian Lands, you must contact the Bureau of Indian Affairs or the local Tribal Council. It is important to stress that you are collecting fossils, not archaeological material.

Please remember the difference between a ***paleontological*** *and an* ***archaeological*** *specimen. Archaeological specimens are any remains that indicate human activity: potsherds, arrow heads, etc. There are very potent federal and state laws protecting collection of artifacts on any type of land. Avoid collection of any archaeological artifacts. Permits to collect fossils do not cover the collection of archaeological materials.*

Road kills. Road kills can be collected with the goal of skeletonizing or freeze-drying them. In New Mexico, a salvage permit obtained from the State Fish and Game Department is required to collect such material. It should be noted that fur-bearing animals (animals whose pelts are of commercial value) and most birds-of-prey are protected by state and federal laws.

A review of your institution's policy on bringing biological materials into your museum is also recommended.

Care and proper discretion also should be used when collecting these materials as they may present a possible health hazard (such as transmitting bubonic plague) and a very real odor problem. Consult your museum's curator or bio-preparator on proper collection techniques. We recommend that road kills not be collected unless your institution has the proper facilities to deal with the cleaning of flesh from the desired skeletal material, because insect infestation can damage museum collections and exhibits.

When a road kill is collected, gather as much information as possible regarding the map location, time of year, environmental conditions, and type of terrain (hilly, dry, rocky ground, etc.) in the area in which the animal was found. Good records make a specimen much more valuable by adding information to geographic and seasonal distributions. Any such information should be brought to the attention of a curator, as it may be new and of value.

Cleaning and preparing specimens. Animal remains must be properly cleaned, once the decision has been made to collect them. If the materials collected are only dirty or have a small amount of dried flesh on them, they can be boiled and then soaked for a few days in a mix of either sudsy ammonia and water or Biz and water. (Biz works very well since it has protein-cutting agents.) Not only will the treatment kill off any insect larvae that may be on the remains, but it will also allow for easy cleaning using a scalpel and a strong jet of water.

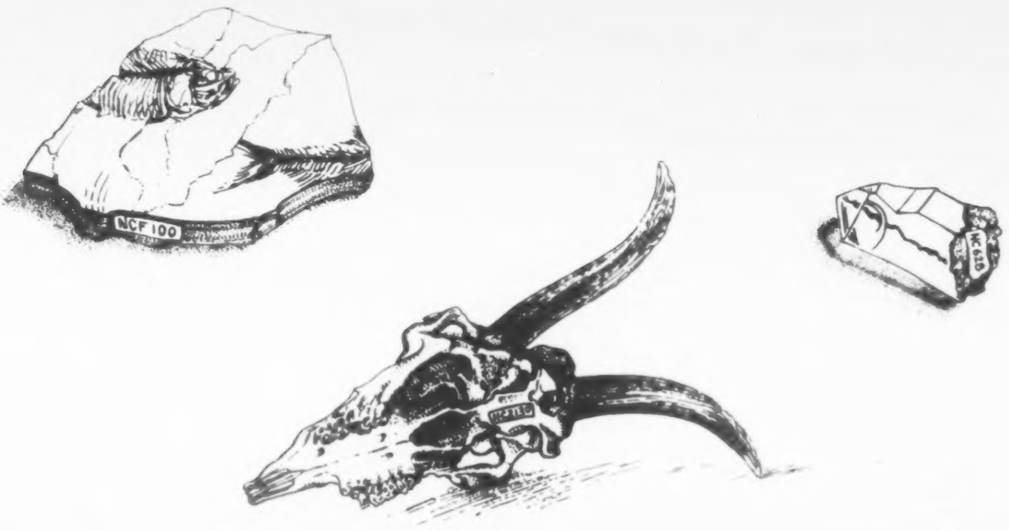
A Dermestid beetle colony is useful for cleaning the flesh from small or sectioned animals that are to be skeletonized. Extreme caution should be taken if a colony is to be set up, as the beetle adults and larvae are voracious eaters and will eat stuffed animals, feathers, and other biological materials. Animals that are to be set in a Dermestid colony for skeletonization should first be skinned and then thoroughly dried. Dermestids will not eat wet or rotting food.

If a skull or other skeletal part needs bleaching, it can be soaked in 2% H_2O_2 for a few days. *Be very careful not to mix cleansing chemicals, as they may react with one another and produce toxic gases!*

Skulls and other skeletal elements that have been exposed to the elements for a while tend to get dry and brittle. Specimens in this condition can be painted with a 1:1 ratio mix of white glue and water, painting on just enough to allow the mixture to soak in. The mixture is inexpensive and non-toxic, and does not give off any harmful fumes.

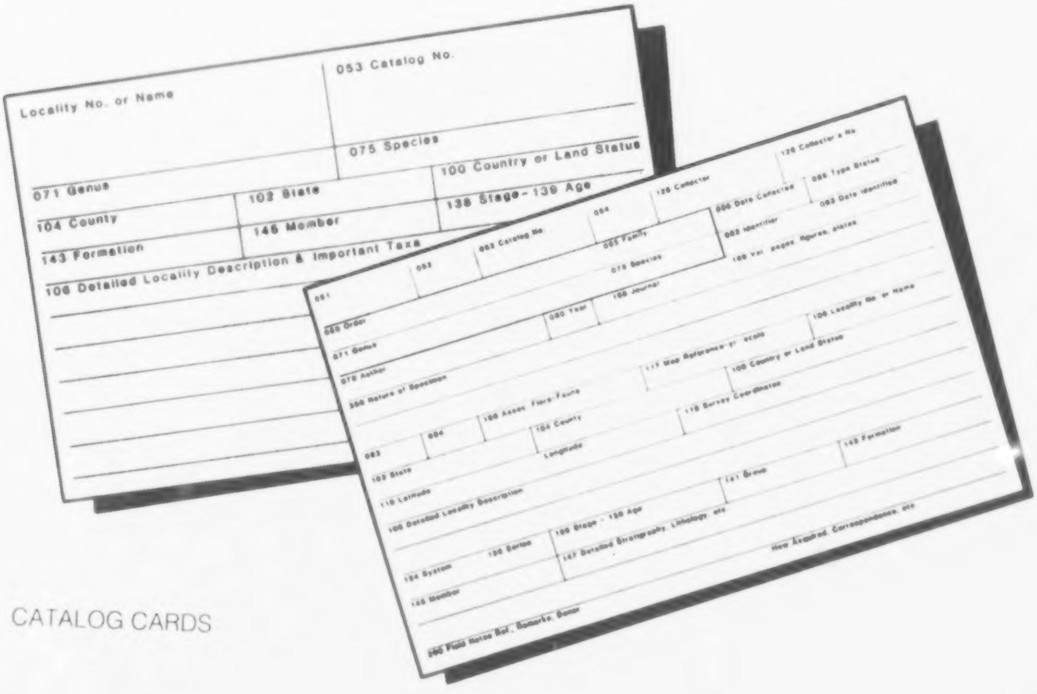
Cataloging and labeling specimens. The value of a collection is greatly enhanced if a specimen is properly labeled and documented. Our collections are housed in the Naturalist Center (NC). Records are maintained both on cards in a card catalog and on 3.5" diskettes using a Macintosh computer program called "Hypercard."

The collections are divided into three parts: the fossil collection (NCF), the mineral/geological collection (NCG), and the zoological collection (NCZ). (We are presently developing a botanical collection.) When a specimen is brought in to be cataloged, it first receives the appropriate three letter suffix (NCF, Z or G) and the next sequential number in the card catalog. This information is written in over a small rectangular area, in an inconspicuous place on the specimen, that has been painted white. On mineral specimens, a crystal face will usually do; on a skull, the palate or the base of the skull is a fairly good place; and on a fossil, a place on the matrix or a spot that is fairly smooth will do. Using white paint as the background, India ink for the letters and numbers, and a coat of clear nail polish to protect the label works well.



LABELING SPECIMENS

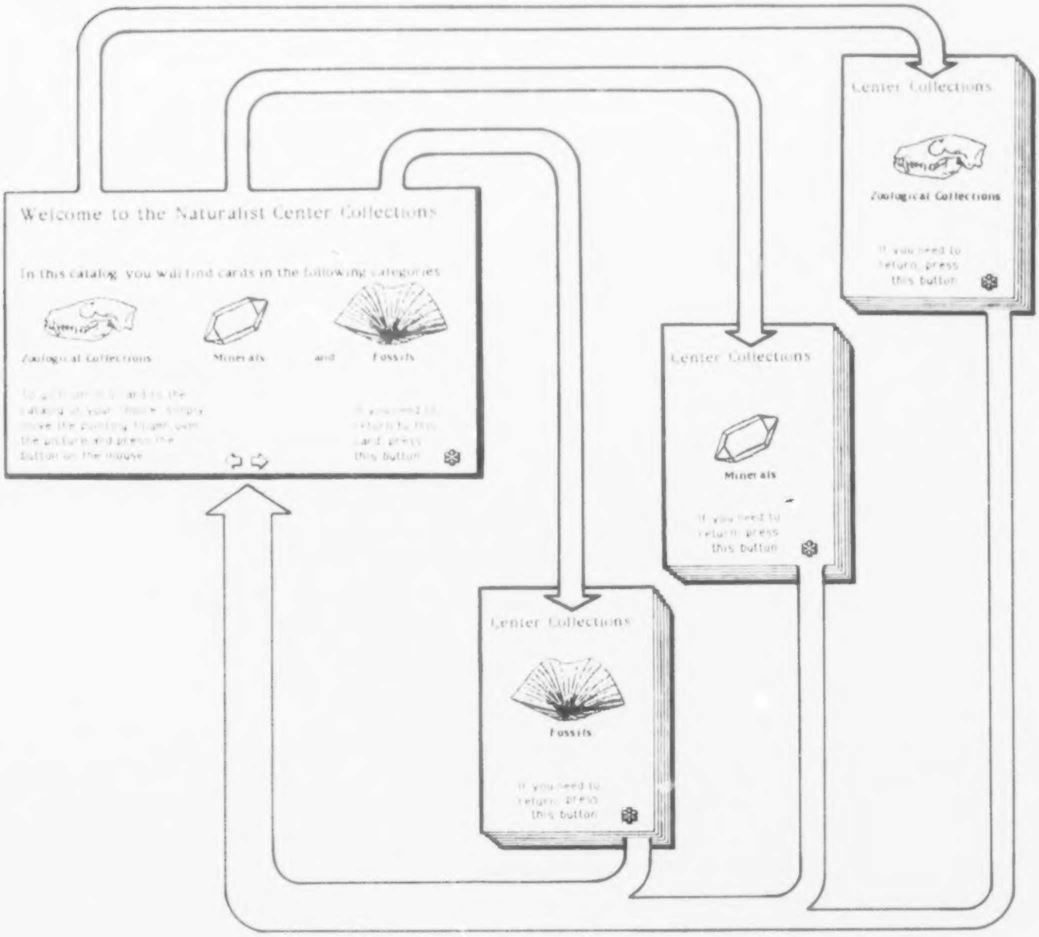
All information that can be obtained about the specimen should be noted on a catalog card and entered in the computer. The cards used for cataloging fossils and biological materials are different; the types of information asked for on the cards are different. The more information that can be obtained and written on a card, the more useful that specimen will be.


Locality No. or Name
053 Catalog No.
075 Species
100 Country or Land Status
071 Genus
102 State
138 Stage-139 Age
104 County
146 Member
143 Formation
106 Detailed Locality Description & Important Taxa
051
052
053 Catalog No.
054
126 Collector
128 Collector's No
055 Family
060 Date Collected
065 Type Status
062 Identifier
063 Date Identified
075 Species
100 Vol. pages, figures, plates
050 Order
080 Year
100 Journal
106 Locality No. or Name
071 Genus
117 Map Reference & scale
100 Country or Land Status
070 Author
300 Nature of Specimen
118 Survey Coordinates
100 Assoc. Flora-Fauna
083
084
104 County
Longitude
143 Formation
102 State
110 Latitude
141 Group
106 Detailed Locality Description
138 Stage - 139 Age
147 Detailed Stratigraphy, Lithology, etc
How Acquired, Correspondence, etc
134 System
136 Series
146 Member
Field Notes Ref., Remarks, Donor

CATALOG CARDS

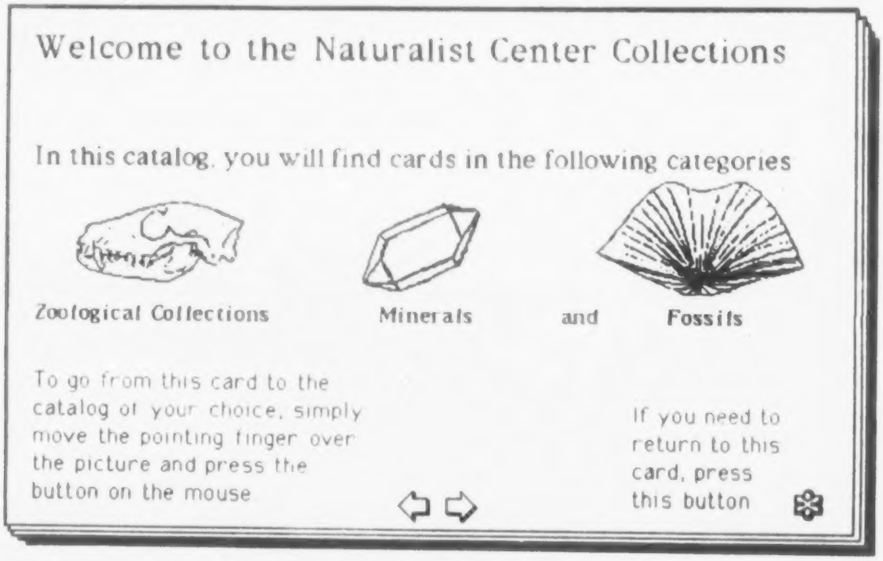
Keeping the card catalog on a computer file has some wonderful advantages. A huge amount of information can be stored on a single 3.5" disk, saving space. The computer can sort and deliver information more quickly than it could be obtained by sorting through a card catalog. But be sure to "back up" your computer files!

Setting up a computer card catalog on Hypercard is not difficult. Below is a flow chart that illustrates the relationship among the museum's three different catalogs (Naturalist Center Fossil, Mineral, and Zoological collections) and the ways they are linked.


Welcome to the Naturalist Center Collections
In this catalog you will find cards in the following categories
Zoological Collections
Minerals
and
Fossils
To go from this card to the catalog of your choice, simply move the pointing finger over the picture and press the button on the mouse
If you need to return to this card, press this button
Center Collections
Zoological Collections
If you need to return, press this button
Center Collections
Minerals
If you need to return, press this button
Center Collections
Fossils
If you need to return, press this button

As can be seen, the catalog is set up as three different stacks of cards, each stack having been assigned a name. In each stack, the cards produced each have a number assigned to them by the computer. The numbers allow the computer to find an individual card in a specific stack.

In the Hypercard file for the Naturalist Center collection, the "Home Card" is a card to which each card in all three catalog stacks will return if the appropriate "button" is pressed. By pressing the "button" over the picture representing the different catalogs on the "Home Card," the user will gain access to the desired stack of cards.



Welcome to the Naturalist Center Collections

In this catalog, you will find cards in the following categories

Zoological Collections **Minerals** and **Fossils**

To go from this card to the catalog of your choice, simply move the pointing finger over the picture and press the button on the mouse

If you need to return to this card, press this button

Listed below are some books that are recommended reading if you undertake this project:

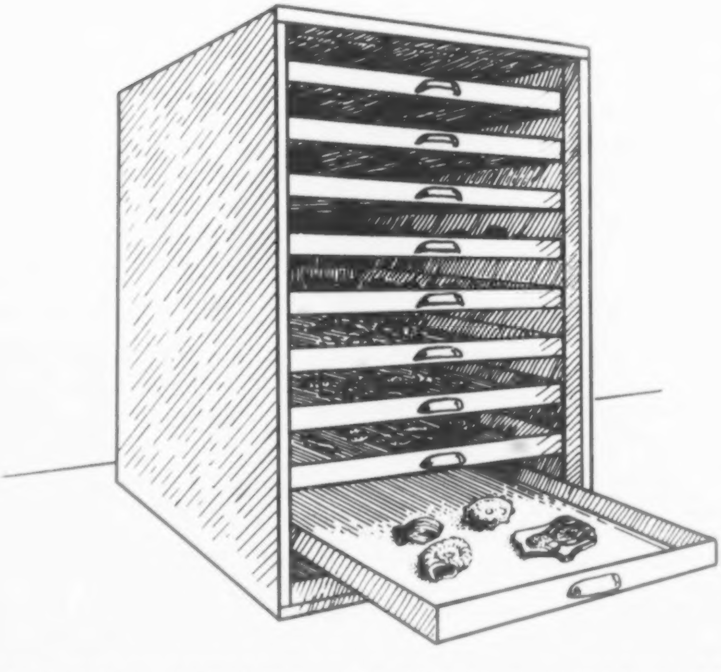
1. *The Complete Hypercard Handbook*
   by Danny Goodman
   Published by Bantam Press

2. *Tricks of the Hypertalk Masters* and
   Hypertalk Bible
   by The Waite Group
   Published by Howard Sams Publishers

Storage of collections. Collections can be organized in any number of different ways, depending on what is being emphasized or taught. As an example, a collection of fossils can be arranged by geologic age, phylogenetically (by phylum, class, order, etc.), or by habitat. Our fossil collection is organized by geologic age regardless of what number it has been assigned. The collection is further subdivided into major groups represented in the collection. Within the Pennsylvanian section, for example, there is a drawer labeled "Pennsylvanian Plants," another labeled "Pennsylvanian Invertebrates," and yet another labeled "Pennsylvanian Vertebrates." In our Cretaceous section, there is an entire drawer labeled "Cretaceous Ammonites" to house our large collection.

Most of our fossils are housed in two metal storage cabinets. Fossils that are too large for the metal cabinets are stored in an oversized collection area in the room. Cabinets measure 39.5" wide by 38" deep by 39.5" high. Each drawer in which the fossil collection is housed is marked with the age of the fossils in that drawer. The drawers and cabinets are organized by geologic sequence, with Cambrian fossils in the first drawers and fossils of Pleistocene age in the last drawer. The drawer in which the fossil is housed is noted on the card. Minerals are also housed in two places: in oversized and in metal card-filing cabinets. Minerals are organized by chemical composition, beginning with Class I (the native elements: copper, sulphur, silver, etc.) and ending with Class VIII (the silicates: quartz, mica, feldspar, etc.). The other classes of minerals are :

Class II, sulphides
Class III, halides
Class IV, oxides and hydroxides
Class V, carbonates, borates, nitrates
Class VI, sulphates and related minerals
Class VII, phosphates, arsenates, vanadates



Skeletal materials are housed in wooden cabinets on sliding trays. Most of our skeletal materials are skulls; they are arranged sequentially by card catalog number, though the material could be arranged by Class, Order, or Family. Very large skulls, jaws, and bones are stored in an oversized cabinet.

There are a number of sources for storage cabinets. The storage cabinets used for the Education Department's fossil collection were obtained from:

The Steel Fixture Mfg Co.
P. O. 917, Topeka, KS 66601
Ph: (913) 233-8911

Other sources are the various biology supply houses: Ward's Biology Supply, Carolina Biological Supply Company, Sargent-Welch, Fisher, Nasco Science, and many others (see list in chapter 5, "Conducting a Survey Trip: Where to Obtain Needed Equipment").

Sample forms. On the following pages are sample forms used for specimens that come to our collection. The forms used for donations were developed to gather as much information as possible. Forms are to be filled out by the donor with the help of a staff member. By properly interviewing the donor, you can gather much information that the donor may not know is pertinent. The interview is very important since some data, such as the scientific name, chemical category, or geologic formation, will have to be supplied by the interviewer and are often of great interest to the donor. Leaving a donor alone to fill out the form may be both intimidating and frustrating, resulting in needed information being lost.

Most institutions have written policies regarding donations. At the New Mexico Museum of Natural History, the person giving a specimen to the museum must sign a statement saying they understand the following policies:

1. The gift is outright and unconditional.
2. The museum cannot promise exhibition of the specimen.

As with the donation forms, the Collection Sign-out sheet is to be filled out with the aid of Education staff. The following pages present samples of the museum's donation and sign-out sheets.

New Mexico Museum of Natural History
Education Division Geological Collections Donation Sheet

Collector/donor:

Date collected:

County:

State:

Chemical group:

Common name:

Description:

Mine:

If you can, draw a map to the site:

Can you designate where the site is on a topographic map?

If you can, describe the rock formation that the specimen was found in:

Comments:

New Mexico Museum of Natural History
Education Division Biological Collections Donation Sheet

Collector/donor:

Date and time collected:

County: State:

Scientific name: Common name:

Description:

If you can, draw a map to the site:

Describe the site in as much detail as possible:

Can you designate where the site is on a topographic map?

Comments:

New Mexico Museum of Natural History
Education Division Specimen Check-Out Sheet

List all specimens to be checked out. Use additional sheets if necessary.

SPECIMENS	NC # (if marked)

Where and for what purpose will the specimen(s) be used?

Date checked out: ____/____/____ To be returned by: ____/____/____

Signature: ____________________________________

To be filled out by education department staff:

Date returned: ____/____/____

Returned in the same condition as when loaned out? Y N

Comments:

Developing exhibits

We have created several portable exhibits for NMRSEP that have proved to be useful in numerous museum programs. They are used in docent training, displayed in our Naturalist Center, and used in other museum outreach programs as well. Our most successful exhibits are two color posters (with accompanying materials) that illustrate the different mountain life zones found in New Mexico and rock layers found within the state. (See the following pages for sketches of the two posters.) The "Rock Layers of Northern New Mexico" exhibit and an accompanying specimen kit are extremely popular; schools are duplicating it and displaying it, and it is in demand for loan to teachers. The general public finds it fascinating as well. The "Mountain Life Zones" exhibit shows the prevalent trees in some of the biotic communities of New Mexico; it can be accompanied by a kit of appropriate specimens (cones, branches, berries, bark, etc.).

The cost of exhibits like these includes the materials, the artist/designer's time, and your staff's time in supervising its construction. The artwork might be done by a volunteer, personnel from the exhibits department staff, or a contractor.

To develop an exhibit like "Rock Layers of New Mexico," a decision must first be made as to which rock layers are to be represented. Representing all the rock layers in a state, or even a region, may be impossible, so prominent strata in the regions the project is serving or strata that are important paleontologically or economically could be selected. The museum curators of geology and paleontology will have suggestions, and should be consulted on all scientific points. The thickness of the layers depicted should be proportional. Represent very thin layers that are important enough to be included at their maximum relative thickness. The layers in the exhibit should be ordered chronologically, older to younger, from bottom to top. Prominent features within the layers can be represented, as well as the environment of deposition with flora and fauna to the left.

Provide slides or prints of the rock layers for the artist to paint from. The artist will need assistance and supervision to produce a painting that accurately represents the look of the rock layers in the field. For layers with soft slopes such as shales, the right hand side of the layer tapers off in a slope, whereas hard layers like sandstones project out over the softer layers and drop off sharply in cliffs. Columnar jointing in basalts can be represented with the proper shading techniques.

In a handbook to accompany the exhibit, provide a description of the rock layers, the geologic resources found in them, the paleontologic resources with pictures of the animals and plants that lived when the layer was deposited, and a description of the climate of the period. (See the sample pages that follow.) A specimen kit accompanying the exhibit could contain small vials with sediments collected from each of the layers, and rocks and fossils from the layers.

To develop an exhibit like "Mountain Life Zones of New Mexico," determine what life zones/biotic communities are present in the area. Consulting foresters or soil conservationists might help. In New Mexico, and much of the Western U.S., biotic communities can be categorized into deserts, grasslands, piñon-juniper woodlands, pine-oak woodlands, mixed-conifer woodlands, subalpine, alpine tundra, riparian (around water), and aquatic (differing for streams, lakes, ponds, etc.).

Photographs of the trees and areas to be represented will be needed for the artist. A manual to accompany the exhibit could describe each biotic community and the plants and climate that typify it, list other common plants and animals found within the communities, and include graphics of some of these.

Developing slide collections

A slide collection is enormously valuable in a project like NMRSEP. Slides can be used in teacher education programs, loan programs, exhibit development, and staff training, and are an excellent way to store information acquired through field surveys and to document the history and progress of the program.

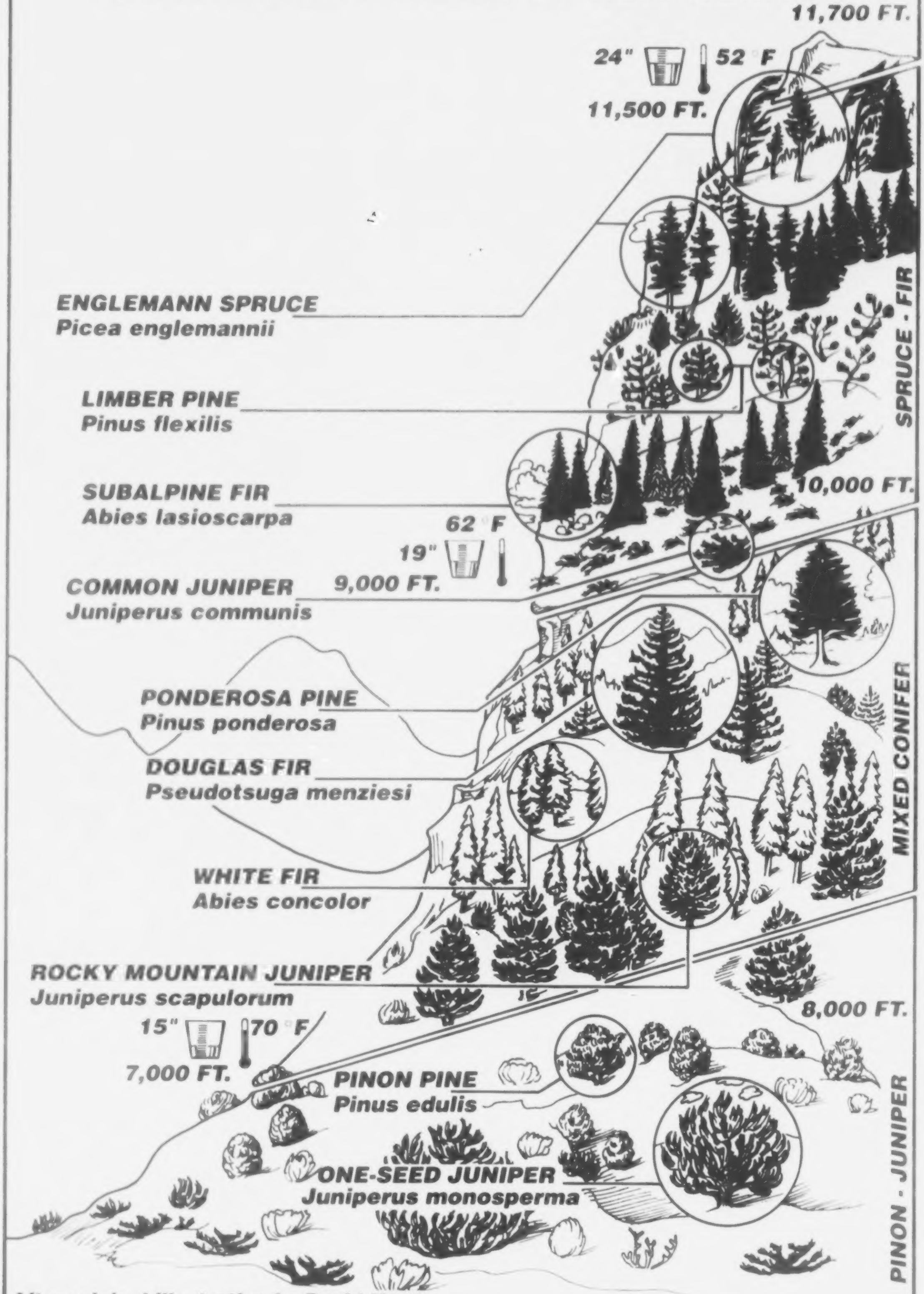
Your slide collection should contain slides of the natural resources in the areas where you are working, including representative life zones, different habitats, animals, plants, rock layers, fossils, and landforms of the area. Slides documenting the programs conducted through the project are useful for publicity. "Before and after" slides of the development of a nature trail, native plant garden, or other exhibit are useful for documenting, replicating, and improving on these processes. Slides of museum exhibits can complement teacher education activities as well.

The equipment necessary to develop and maintain a slide collection include camera equipment to shoot the slides, projector equipment to show the slides, and storage for the slides.

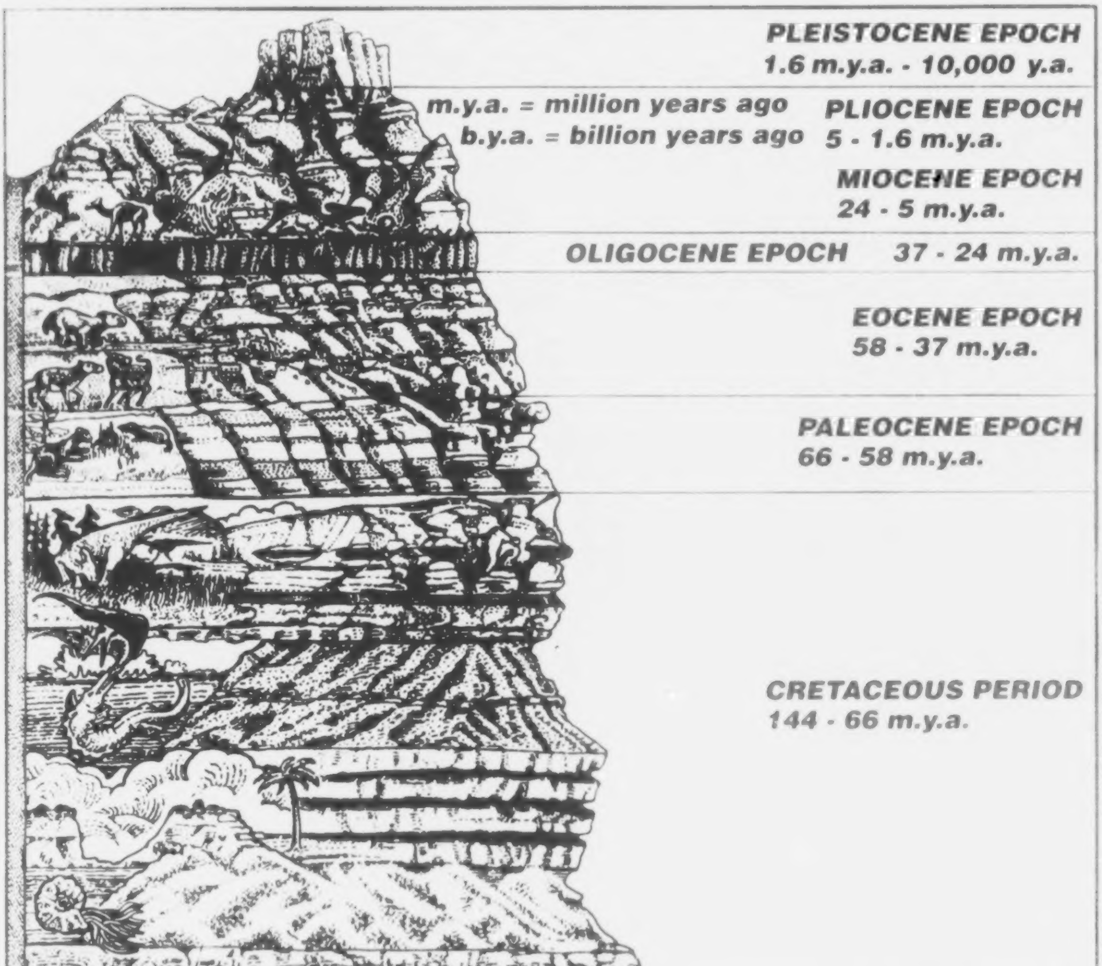
Photography. A 35mm camera with 50mm lens, and appropriate slide film such as Kodachrome 64 or Ektachrome 100 HC and Ektachrome 400 for cloudy days are a good start. A macro-zoom lens (such as 35-135mm) provides flexibility in the field, allowing for wide angle shots of landscapes, distance shots, and close-ups of small plants and animals. A tripod steadies the camera to allow use of slower films for finer grain shots.

Presentation. An auto-focus, carousel projector with a zoom lens is optimal for slide presentations. Always take along an extra bulb and an extension cord when making presentations. Four-leg portable projector stands are convenient. A remote slide changer with a long cord allows mobility during the presentation. A light table is great for preparing presentations.

MOUNTAIN LIFE ZONES OF NEW MEXICO


11,700 FT.
24"
52 °F
11,500 FT.
ENGLEMANN SPRUCE
Picea englemannii
LIMBER PINE
Pinus flexilis
SPRUCE - FIR
SUBALPINE FIR
Abies lasioscarpa
10,000 FT.
62 °F
19"
COMMON JUNIPER
Juniperus communis
9,000 FT.
PONDEROSA PINE
Pinus ponderosa
DOUGLAS FIR
Pseudotsuga menziesi
MIXED CONIFER
WHITE FIR
Abies concolor
ROCKY MOUNTAIN JUNIPER
Juniperus scapulorum
8,000 FT.
15"
70 °F
7,000 FT.
PINON PINE
Pinus edulis
ONE-SEED JUNIPER
Juniperus monosperma
PINON - JUNIPER

After original illustration by David North


PLEISTOCENE EPOCH
1.6 m.y.a. - 10,000 y.a.
m.y.a. = million years ago
b.y.a. = billion years ago
PLIOCENE EPOCH
5 - 1.6 m.y.a.
MIOCENE EPOCH
24 - 5 m.y.a.
OLIGOCENE EPOCH 37 - 24 m.y.a.
EOCENE EPOCH
58 - 37 m.y.a.
PALEOCENE EPOCH
66 - 58 m.y.a.
CRETACEOUS PERIOD
144 - 66 m.y.a.
JURASSIC PERIOD
208 - 144 m.y.a.
TRIASSIC PERIOD
245 - 208 m.y.a.
PERMIAN PERIOD
285 - 245 m.y.a.
PENNSYLVANIAN PERIOD
320 - 285 m.y.a.
PRECAMBRIAN PERIOD
4.6 b.y.a. - 570 m.y.a.

After original illustration by David North

ROCK LAYERS OF NORTHERN NEW MEXICO

Sample Pages from "Rock Layers of Northern New Mexico" Stratigraphy Exhibit Manual

Pennsylvanian Period
310-280 Million Years Ago

Shallow seas and coastal deltas deposited the Pennsylvanian rocks in New Mexico. The deeper sea deposits are limestones, while shales (marine muds) were deposited in shallow, lagoonal waters. Primitive plants lived on the banks of deltas and estuaries. Primitive fish swam in the waters. Many Pennsylvanian fossils are preserved in northern New Mexico's mountains.

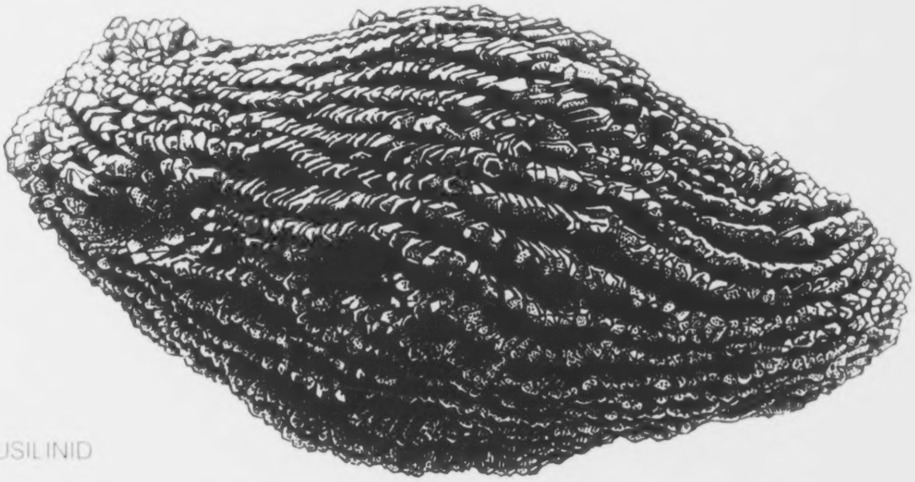
Rock formations in the painting:

Madera Formation: These rocks are limestones together with some shales and mudstones deposited by the Pennsylvanian sea in New Mexico. The Kinney Brick Quarry, a site southeast of Albuquerque in the Manzano Mountains, and the fossiliferous rocks in the Battleship Rock area in the Jemez Mountains are from this formation.

Animals in the painting:

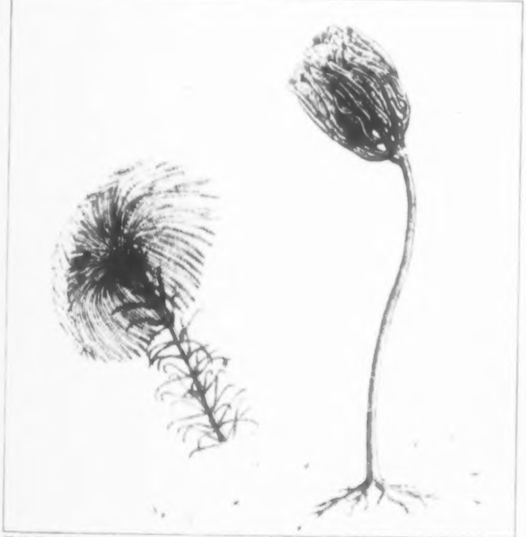
Fusilinids: Fusilinids (pronounced FUSE-i-lin-ids) were protozoans (Phylum Protozoa). These single-celled organisms had "pseudopodia," which were primitive feet-like organs responsible for food gathering and enabling the animal to move through the water.

Fusilinids ranged in size from microscopic to the size of a grain of rice. They evolved in the Ordovician and became extinct in the Triassic.



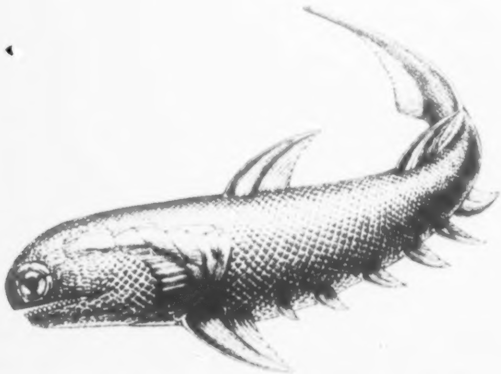
FUSILINID

Crinoids: Crinoids (pronounced CRY-noids) are the most abundant fossil echinoderms. Echinoderms are spiny-skinned animals like starfish, sand dollars, and sea urchins. Look for the star-shape in the center of the stem reflecting the five-part symmetry of echinoderms (see illustration). Crinoids were attached to the ocean bottom and lived in vast colonies in shallow, warm seas. Crinoids had a bud-like calyx with numerous arms used in filter feeding. The calyx is situated at the end of a long stem. The stem is the part of the crinoid that is most commonly found.



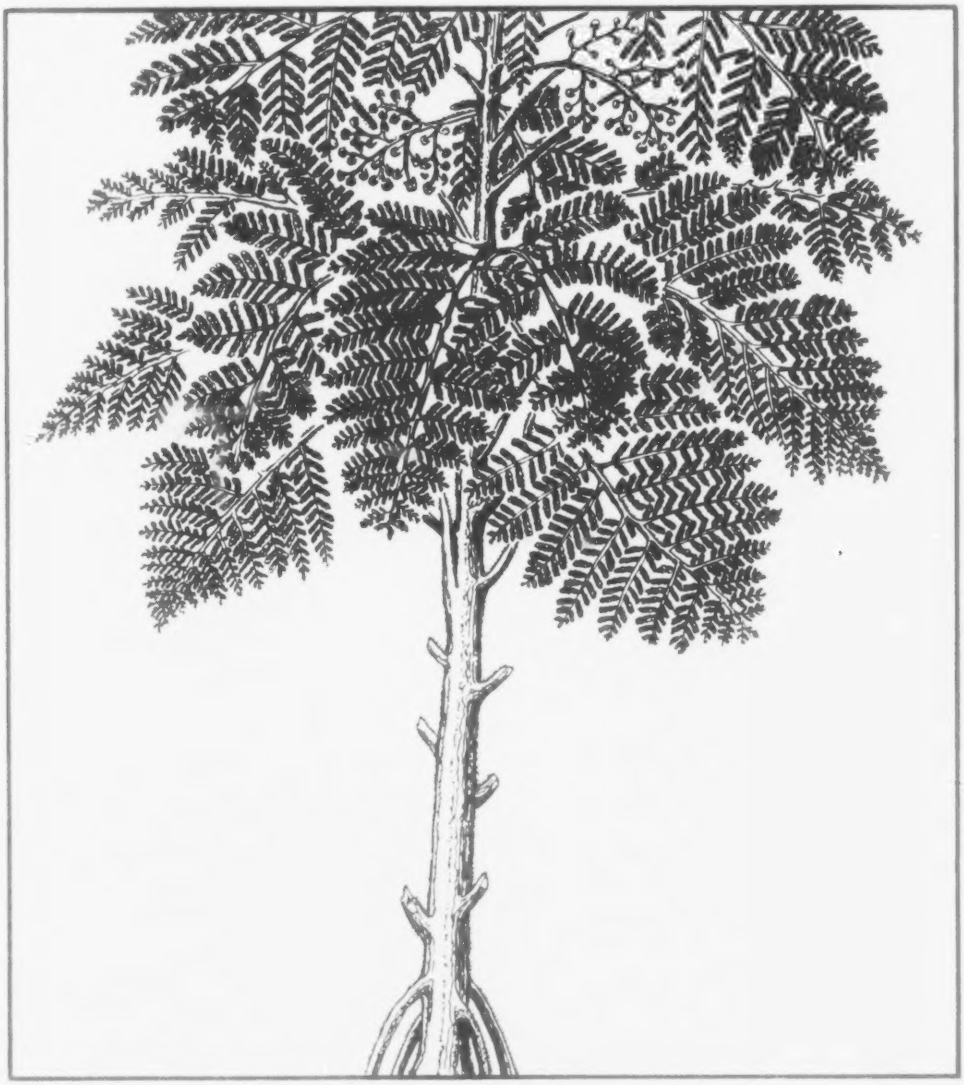
PRESENT DAY 350 MILLION YEARS AGO

Acanthodian Fish: Acanthodian (A-can-THO-dee-un) fishes are the first jawed fish to appear in the fossil record. They are known from the Silurian Period to the Permian Period. Finely preserved fossil fish have been found in the Kinney Brick Quarry. The site has rocks that vary from limestones deposited in deeper water, to lagoonal deposits, to what seems to have been a deltaic deposit with local areas of still fresh water containing abundant plant materials -- mostly spore-reproducing plants, freshwater pelecypods (clams), and primitive freshwater fish like *Acanthodes* and *Paleonisconis*.



Plants in the painting:

Seed Fern: Seed ferns are an extinct group of plants that were the first plants to bear seeds. They are the ancestors of conifers. The preservation of ferns in clay-bearing rock called shale is not unlike pressing leaves into the pages of a book. Fine sediments covered the leaves and pressed them flat. The impressions of plants are commonly found in shale, since pieces of the shale "cleave" or break off easily in flat slabs.



Based on a drawing from Berry, illus.
Plants of the Past

Storage. Slides should be stored either in archival slide-holders or an appropriate cabinet. The following resources may help you locate storage equipment:

Slide Storage Systems:
Abodia Slide Cabinets
Elden Enterprises
P. O. Box 3201
Charleston, WV 25332
(304) 344-2335

Professional Archival Labels:
Slide Scribe
690 Mendelssohn Avenue
Minneapolis, MN 55427

Archival Slide Preservers:
Print File, Inc.
P.O. Box 607638
Orlando, FL 32860-7638

8. CONDUCTING TEACHER EDUCATION AND SUPPORT ACTIVITIES

NMRSEP has offered a variety of education and demonstration activities for teachers. Based on our experience, we recommend that you offer a range of possibilities as you negotiate your plan of work, and that you always try to schedule at least two workshop sessions per year with any school or district you serve. A single program, even a day-long inservice, simply is not enough to give teachers the support they need. A second session allows teachers to give you feedback about what they tried that did or did not work, to ask follow-up questions, to reinforce what they have learned, and to expand new skills. It also helps demonstrate that this is not just another fly-by-night program they might just as well ignore, and it gives you more opportunity to build good working relationships.

NMRSEP has offered the following teacher education or support activities, each of which will be discussed in this chapter:

- inservice workshops, including sessions that take teachers on field trips to areas discovered on the field survey trip,
- outdoor field schools, day-long science festivals in which students move from one outdoor learning station to another; NMRSEP staff either conduct the field schools, modeling the instructional activitiesfor teachers, or work with teachers to help them plan and conduct learning activities,
- a five-day Summer Elementary Science Teachers' Institute (SESTI), in which teachers from a number of rural school districts gather for intensive training in science content and instructional strategies, and
- follow-up support, through which NMRSEP staff consult with individual teachers to address problems and provide supplementary resources for classroom instruction. NMRSEP staff have also worked with schools to set up nature trails and other special science programs.

Inservice Workshops

Your initial resource and inservice needs surveys (see chapter 4), along with the field survey trip and subsequent manual, will suggest appropriate topics for teacher education. A community with ponds will put pond life on your inservice agenda. If coal is mined in the area, you might cover coal formation, mining, and use. Topics should also mesh with the field trip sites for the inservice. An introduction to the geology and ecology of the area is important before the group embarks on a field trip.

Always stress science concepts, such as the rock cycle, for example. Bring teachers' attention to local resources and interesting features of the landscape. Explain how you surveyed their area and how they can continue and extend the survey. Present them with examples of learning activities that emphasize local natural history, appropriate science concepts, and process skills. Assist them in adapting generic activities to suit their area's resources. If possible, invite local resource personnel to the workshop sessions and introduce them to teachers. Show samples of free resource materials that teachers can obtain from local agencies.

NMRSEP generally provides participating schools with two day-long inservice workshops during the school year. Two, one-day workshops are an effective format for presenting an adequate amount of material to teachers in one year. This is also about the extent to which available inservice days exist in many school calendars (some have none). Teachers have elected to come in on Saturdays in some cases, but it is preferable to use designated inservice days whenever possible.

The number and schedule for the workshops need to be worked out as early in the school year as possible; some schools set their annual inservice calendars as early as the summer before the school year begins. Once your schedule is set, do not rely on the school superintendent or principal alone to inform teachers about your upcoming workshops. (We once arrived at a school to conduct a workshop, only to discover that the teachers were not even expecting us! Needless to say, when the principal "rounded them up," they were not a receptive audience!) Use both your official and your working contacts to let teachers know what to expect. Sending the school an exciting and interesting flyer announcing the coming inservice program is another strategy, and a way to develop teacher enthusiasm for the program ahead of time.

Of vital importance to a successful inservice is the enthusiasm of the facilitators. Enthusiastic facilitators can usually overcome any sort of fear and resistance on the part of teachers. Teachers see that science is fun and exciting and forget their concerns about science being difficult.

In the first inservice, explain your objectives, start with an ice breaker activity or two, then introduce teachers to the natural history of their area. Sample icebreakers are "Timeline" and "Prehistory Mystery" (both are described in chapter 6). Present a slide show covering local geology and paleontology. Then deliver an overview of the ecology of the area, including local life zones, plants, and animals. (Teachers already should have received the manual on the natural history of the region, which contains much of the information presented in these introductions.) Again, always stress science concepts rather than merely presenting specific facts.

In the afternoon, take a field trip to view rocks, fossils, plants, stream life, etc. in the area. (Never assume that participants will dress appropriately for a field trip. Provide information recommending proper footwear, a hat, pants, sunscreen, and if needed in your area, insect repellant.)

The first inservice might end with a sharing of resources, books, maps, and free materials from agencies like the U.S. Forest Service and U.S.D.A. Soil Conservation Service. Have teachers fill out an evaluation form, to help you assess the inservice and to give teachers an opportunity to list areas for which they would like follow-up assistance.

The second inservice can be devoted to modeling hands-on activities that teachers can use with their students. Using hands-on approaches and modeling the behavior for teachers to adopt makes learning fun as well as productive. Teachers are active during most of the program, which helps maintain their interest. They learn first-hand how to conduct exciting activities using their local resources, and acquire the necessary background information. You can set up learning stations in various natural areas at a site around or near the school (and/or indoors if necessary), and have groups of teachers rotate from station to station. Depending on the number of teachers you must handle, each activity may take 30-45 minutes. The following is a sample agenda (note that transition time is provided):

8:30 - 9:30	Introduction and review of teachers' progress
9:35 - 10:20	Skulls station
10:20 - 10:35	Break
10:35 - 11:20	Topographic map station
11:25 - 12:10	Mineral station
12:10 - 1:00	Lunch
1:00 - 1:30	Plant station
1:35 - 2:05	Symbiosis station
2:10 - 2:40	Dinosaur art station
2:45 - 3:00	Break
3:00 - 3:45	Questions and answers
3:45 - 4:00	Evaluation and wrapup

Whenever you plan out-of-doors activities, always have a contingency plan and schedule. Here are a few other tips to keep in mind when planning your schedule:

- Try not to schedule a slide show after lunch -- the participants will probably be drowsy and the last thing they need is to be put in a dark room!
- If the weather is going to be hot, plan field trips for the morning; if the weather is cold, plan the field trip for the afternoon, when the day will be warmer.
- Plan to alternate participatory activities with non-active activities. This prevents the participants from getting bored or tired.
- Always plan to bring or have available at least one more person than is absolutely essential to the conduct of your program. That way you are covered in case someone cancels or becomes ill. And an extra hand is always needed to make a program run smoothly. The extra hand also can conduct an activity, freeing you to coordinate, keep time, and organize.

Volunteers are invaluable resources in conducting workshop sessions. They can act as that extra hand or emergency stand-in. Volunteers also may have knowledge or expertise in a particular subject, or may be gifted teachers who can conduct learning activities.

One good way to add excitement to your inservice is to award prizes such as posters or booklets for various good or not so good reasons. We have awarded prizes for the most accurate representation of a dinosaur, for the funniest song about symbiosis, and for the most/least number of correct answers to a "what in the world was(is) it" game quiz. The possibilities are almost endless.

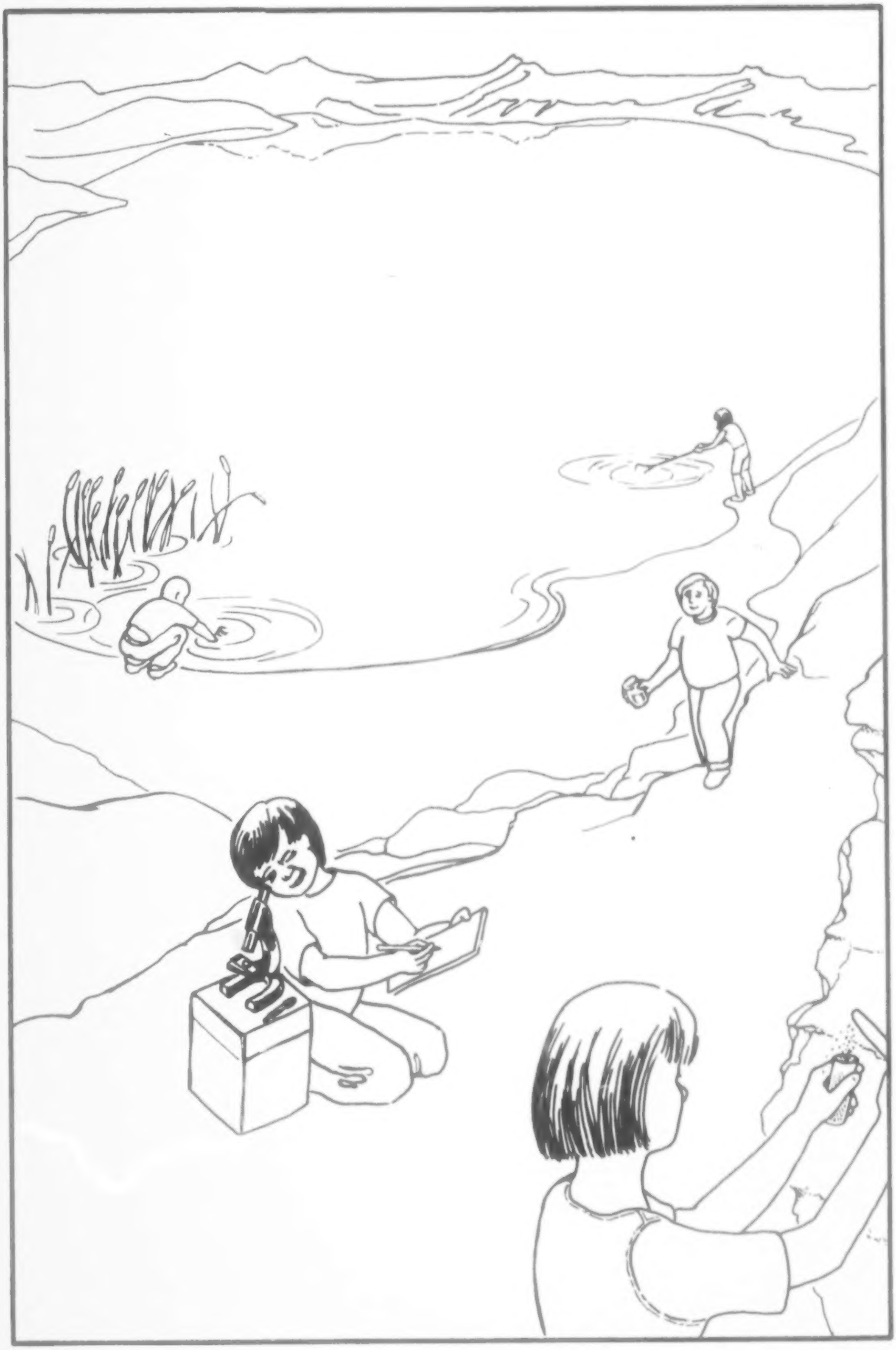
Field schools

Field schools are outdoor science festivals, usually lasting all day. Students move from one activity station to another, with each station engaging them in a hands-on learning activity that uses local natural resources to teach a science concept. The primary goals of field schools are to show students that science can be fun, to focus attention on the immediate natural environment, and to address the year-long science goals and objectives of teachers.

NMRSEP has used field schools as a way of modeling learning activities for teachers; we also help teachers to organize and conduct their own field schools. Natural history field schools can be exciting and popular one or two-day events that function well to kick off the year's science study. Students, teachers, and parents come away bubbling with enthusiasm for the natural sciences. With proper follow-up, this enthusiasm can be tapped throughout the school year. This is not to say, however, that a field school cannot be held at any other time of year. Field schools can be held any time of the year; they can even be conducted indoors.

Planning a field school. Putting together the pieces to create a successful field school is an arduous but worthwhile task. A committee of teachers, administrators, and parents should be assigned responsibility to do the necessary groundwork. At least two months may need to be set aside in order to complete the necessary tasks, which include the following:

1. Select a field school site, and an alternative indoor site.
2. Determine the number of activity stations needed. One station per 10 children is a workable plan.
3. Recruit field school instructors and assistants to plan and staff activity stations.
4. With instructors, conduct a natural resource survey of the site. Identify natural resource activity stations. Collect specimens for use in the field school and follow-up activities.
5. Correlate activity stations with the school curriculum. Plan follow-up classroom activities.
6. Send out field school information, parent invitations, and permission forms.
7. Arrange for buses or any needed school facilities.



8. Prepare signs identifying each activity station.
9. Prepare name tags, buttons, banners, and other festive decorations.
10. Gather science materials as needed for each activity station.
11. Gather all instructors, assistants, teachers, and parents for a last minute meeting to trouble shoot at the field school site.

Selecting a site. The site you identify might be a Bureau of Land Management, U.S. Forest Service, state, national, or local park or campground. It might be located on land owned by the parents of one of your students. Some school districts are lucky enough to have their own outdoor natural areas that are ideal for field school programs. Select a site for your field school that comes as close as possible to meeting these criteria:

- The site contains natural resources that complement your science teaching goals (e.g., water, soil, flowers, trees, birds).

- The site is within a 30 minute drive from school. The closer you can get to the school without compromising too much on the other criteria, the better. It is best to minimize travel time and maximize field school activity time.

- The site contains restrooms and picnic benches. Without these, your task will require some creative planning (e.g., portapotties, latrines, portable tables for microscopes and specimens).

- The site has drinking water available. This is not essential, but be sure to bring enough drinking water if none is available at the site.

- The site has shade available. In New Mexico and the Southwest in general, this is a very important factor. A natural history field school is a day-long event, and over-exposure to the sun can be a serious hazard.

Recruiting field school instructors. To locate field school instructors, encourage teachers to start with their fellow teachers and administrators. No doubt the faculty of the school or a neighboring elementary, middle, or high school will include naturalists, birdwatchers, geology buffs, rockhounds, or wildlife and wildflower enthusiasts. In many cases, parents have knowledge of local natural history, have good communication skills, and are glad to be of help to their children's school. Besides museum staff and volunteers, other potential sources of field school instructors include government resource management agencies such as the U.S. Forest Service, Bureau of Land Management, Soil Conservation Service, State Game and Fish, and State Forestry Department. If you are lucky enough to have a professional scientist or resource manager take part, then he or she can also bring a career education component to the field school by sharing with children the kind of work that they do, how it relates to the resource under study, and what skills and knowledge children need in order to do that kind of work.

Contact instructors well ahead of time to allow them to make room for the program in their own schedules and to plan their programs. Give each instructor a field school activity station form and have them describe what it is that children will do at their station. Let them know in advance that you want an active child-centered program and not an instructor-centered lecture-in-the-field. Some scientists who are not used to talking with children about their work are prone to lecture. Try to screen potential instructors by speaking first to their supervisors or others who have worked with them. You might also match up dynamic teachers or parents with scientists who are strong in subject matter but weak as teachers of children. As an extreme alternative, you might also consider having a government scientist or resource manager help with the site survey and suggest possible resource-related points to stress, and then have a skillful teacher develop and conduct the activities.

Surveying the site with instructors. Once you have identified your instructors and assistants, schedule a field trip to the site to allow instructors to stake out locations for their activity stations and collect specimens for use in the field school and follow-up classroom activities. Having seen the field school site, they can now begin planning the details of their activities. Develop enough activity stations so that not more than 10 children are at any one activity station at one time.

Finding assistants. Some parents may be very knowledgeable about one or more of the natural sciences and might be called upon to conduct a station of their own. Parents can also serve as organizers and helpers. In any case, parents should be informed about the field school program and invited to participate. Parent involvement in the field school will also serve an important educational goal: to bridge the gap between school activities and students' home life. Parents and children learn together at the field school and reinforce their learning during family outings, picnics, backyard gardening, or visits to your museum.

Parent volunteers or teachers who want to participate but do not feel competent to be in charge can assist by helping instructors gather the equipment and materials they will need to conduct field school activities. They should remain in communication with instructors and with the person who is coordinating the field school, so that all materials are gathered and prepared on time for the field school. These people can also supervise groups as they travel from station to station in the field school.

Correlating field school activities with the school curriculum. Gather the descriptions of activities prepared by field school instructors and group them according to science curriculum subject matter, process goals and objectives for the year, and/or chapters in the science textbook. Give each classroom teacher whose students will participate in the field school the list of grouped activities so that they can see the relationship between the field school and the curriculum. Also, at this time, field school instructors and teachers should plan classroom activities that follow-up on the field school.

Scheduling the field school. The following is a sample schedule for a day-long field school:

7:00-8:00 a.m. Field school instructors and assistants hang banners and signs to add to the excitement and festive atmosphere of the field school. Instructors collect last minute specimens. Each instructor is given one set of identical buttons with a pertinent symbol such as a crystal, a fossil, or a flower, to distribute to the children in their first group of the morning. This allows groups to maintain integrity and lessens confusion as to who is in which group and where they should be.

9:00 a.m. The buses arrive bringing children and adult supervisors to the field school, unless the program is being held on school grounds or indoors. Children have already been divided into groups by their teacher and know who their adult supervisor is. All of the children and adults sit in a convenient location, where they are greeted and briefed by the field school coordinator who covers these points:

- Welcome students and introduce them to the field school concept.
- Explain the reasons for remaining in groups and stress the importance of staying with your group and its supervisors.
- Introduce the topics to be taught and the instructors who will teach them.
- Explain the signal for changing stations, which could be a whistle, horn, or school bell.

9:30 a.m. - 12:00 noon and 1:00 - 2:45 p.m. Groups of students and adults (parents or teachers) participate in activities at activity stations staffed by teachers, museum personnel, U.S. Forest Service, or State/Tribal Game and Fish personnel.

Subject areas or concepts to focus on in your activity stations should be selected to highlight the local environment and to correlate with the school's science curriculum. The following subject areas and activities could be included in stations at a field school:

- **Trees** - conduct surveys of the various species of trees on the site, estimate the ages of trees, and then determine the ages using an increment borer.
- **Birds** - dissect owl pellets in order to determine the eating habits of owls.
- **Pond/Stream Life** - collect samples of stream sediments and water and examine them using hand lenses and microscopes in order to gain an appreciation of the diversity of stream life.
- **Weather and Microclimates** - measure temperatures in a multitude of specific environments (e.g., under rocks) in order to discover the concept of a microenvironment.
- **Rocks and Minerals** - test local rock samples in order to determine which are limestone.

- **Fossils** - remove invertebrate fossils from local rock in order to typify the paleo-environment.
- **Nature Sketching** - collect three types of leaves and sketch each one in detail, observing similarities and differences in leaf structure.
- **Environmental Gaming** - role play animals constructing their homes and compare the effectiveness of students' anatomy to that of the animal they are portraying.
- **Microscopes** - collect water samples, examine them under microscopes, and sketch what is seen.
- **Insects** - collect insects with nets, noting where they are concentrated in the environment (on plants, above water), and examine them under the microscope to classify them.
- **Orienteering** - use compasses to navigate an orienteering course.
- **Erosion** - observe areas with high concentrations of plants versus barren areas; pour water on inclined surfaces in these areas to measure differences in rates of erosion.

Field schools, especially school-wide field schools, are large, exhausting efforts. We developed and tested many of our teaching strategies through field schools, but we have found that to continue conducting large field schools is not practical. Instead, we encourage teachers to organize and conduct their own field schools, calling on us to serve as "volunteer" instructors as needed. We also encourage teachers to limit their efforts to one or two grade levels rather than the entire school, to avoid their own "burn-out."

Intensive summer teacher institutes

A variation on field schools and inservices is an intensive summer teachers' institute. NMRSEP has conducted one five-day residential workshop, which was offered to teachers selected from participating rural school districts. Teachers were positive and enthusiastic in their evaluation of the institute.

In addition to project staff from the museum and the New Mexico Center For Rural Education, the workshop attracted many volunteer faculty such as the museum's curator of zoology, an education specialist at the museum who specializes in integrating art and nature, a mathematician and amateur astronomer at the University of New Mexico, a soil conservationist from the U.S.D.A. Soil Conservation Service, a wildlife biologist with the New Mexico Department of Game and Fish, and a forester with the U.S. Forest Service. Teachers and staff participated in a wide variety of science activities and explored the natural resources of the area around the Circle A Ranch in the

Nacimiento Mountains just east of Cuba, New Mexico. Activities included measuring stream flow, microhabitat studies, nature art, natural history games, insect identification, fossil collection techniques, soil sifting and classifying, skull comparisons, astronomy, and others. Through these activities, teachers gained extensive hands-on experiences in natural science field studies. It was an opportunity for project staff to offer rural teachers the best of the ideas, activities, and information developed through NMRSEP.

Each activity at the workshop focused on the immediate environment of the Circle A Ranch and vicinity. However, skills and activities learned during the week were transferable to each of the participating school districts. For example, every school represented could conduct studies of locally occurring aquatic life. Some could study streams, some ponds, and some seasonal irrigation ditches or vernal pools. The species of organisms that would be expected to be found would certainly differ, but their ecological niches and the types of student activities used to explore the environments could remain more or less the same. After the workshop, teachers were given a field survey form (see chapter 5) to help them in identifying local natural resources and opportunities for activities. The teachers' surveys elicited many follow-up questions and requests for information.

We also administered a pre-test and a post-test at the beginning and end of the institute, assessing teachers' knowledge of science concepts and facts. All of the teachers' test scores improved significantly on the post-test.

After the workshop, any short story, poem, song, activity, cartoon, or idea that the participants had produced were pulled together for the first edition of the "Natural Inquirer." Material was compiled and formatted on a Macintosh computer. Illustrations (some provided by the teachers themselves) were added and the final product was sent to participating teachers.

If you decide to conduct an intensive summer institute, here are some tips from our experience:

- Warn teachers beforehand about any hiking or other strenuous activities that may be involved. Send them a complete schedule ahead of time, if possible.

- Provide detailed lists of what teachers will need to bring. Our list included: sleeping bag, canteen, rain gear, long pants for hiking, a sweater or light jacket, towels, pillow, hat, sunscreen, insect repellant, hiking shoes, wading shoes, bathing suit, notebook or journal, flashlight, and a copy of the school science curriculum.

- In activities and discussions, stress hypothesis formation and testing; focus on science concepts and offer a lot of supporting information. Do not assume that teachers will know or remember a great deal of science content information.

- Build in plenty of time for teachers to talk with each other and share ideas.

- Have lots of handouts; bring extras.

The following pages present a sample schedule of events.

Providing follow-up assistance

NMRSEP's approach to follow-up has been described by teachers as one of the program's most valuable characteristics. Teachers are accustomed to a great many "drop-in" programs and resources, where an expert presents new and interesting ideas and then just disappears. Often teachers try to use the new ideas or materials, but without opportunities to ask questions, obtain feedback or classification, or build on their introductory knowledge, even the most enthusiastic teachers generally revert to the old, familiar routine. Follow-up is *essential* to the success and long-term use of your program approaches; it is also a service that will build strong support from teachers.

Follow-up assistance can take many forms, from a telephone conversation to a packet of materials, to the loan of a specimen collection, to a school site visit where you observe teachers and meet for informal discussions. We have also helped schools to design nature trails and apply for grant funds to obtain classroom equipment for science studies. The essential ingredients to follow-up are *accessibility* and *responsiveness* to what teachers say they need.

At NMRSEP, we describe our programs for schools as a door opening between the school and the museum. On our inservice evaluation forms, we ask teachers to note any requests they may have for further information or assistance. We try to respond to those requests as soon as we get back to the museum, to demonstrate our commitment and strengthen our working relationships with teachers. We also invite teachers to call us with requests, and we "check in" with the school contact person on occasion. Many times one teacher at a school will emerge as an informal leader or coordinator and will call us on behalf of other teachers. This informal system works well, avoiding duplication, reducing the number of contacts we have to make, and saving the school time and money.

The most frequent requests are for information, learning activities, and the loan of specimens or exhibits. We use other museum staff and volunteers as resources to help locate needed information and resource materials. Our system for lending specimens and exhibits is quite informal; because the cost of shipping or mailing specimen kits or exhibits could be prohibitive for rural schools, we make whatever informal transportation arrangements we can. For example, perhaps a parent is planning a family visit to the museum, or perhaps a museum volunteer plans to travel through the rural community where a specimen kit needs to be picked up.

Whenever we get an information request, we make up a packet of materials, sending the teacher a copy and keeping the original in case other teachers ask for the same information. We have built a file of information packets; when we conduct workshops, we provide teachers a list of the topics for which we have ready-made packets available.

Sample Schedule of Events
Summer Elementary Science Teachers' Institute

Sunday

2:00 p.m.	Arrival and check-in (includes pretest and shower sign-up)
2:00 - 6:30 p.m.	Free time to get settled, get acquainted, and explore
6:30 p.m.	Dinner
8:30 p.m.	Campfire (organize an ice-breaker activity for getting acquainted)

Monday

7:00 a.m.	Breakfast
8:15 - 9:00 a.m.	"Why are we here? What's going on?" (introduce your program, describe your museum's resources for schools)
9:00 - 10:00 a.m.	Orientation hike (conduct an introduction to teaching science using local natural history and science resources)
10:00 a.m. - 12:30 p.m.	Small group activities (switch halfway through): 1. Exploring pond environments (insects, fish, beaver, crayfish, water quality) 2. Teaching about insects
12:30 p.m.	Lunch
2:30 - 3:15 p.m.	Introduction to building a specimen collection
3:15 - 4:00 p.m.	Writing for the *Natural Inquirer*: Your chance to see your name in print!
4:00 - 5:30 p.m.	Microhabitats: An independent study (see activity description, chapter 6)
6:30 p.m.	Dinner
9:00 p.m.	Star party

Tuesday

6:30 a.m.	Breakfast
8:00 a.m. - Noon	Hike (take sack lunches)
Noon - 2:00 p.m.	Journal/*Natural Inquirer* writing, independent study, siesta
2:00 - 2:30 p.m.	Microhabitat observation
2:30 - 5:30 p.m.	Small group activities: 1. Introduction to geology activities 2. Maps and mapping activities
5:30 p.m.	Dinner
8:00 p.m.	Bats lecture

Wednesday

7:00 a.m.	Breakfast
8:00 - 8:30 a.m.	Microhabitat observation
8:30 - 9:30 a.m.	Overview of geology
9:30 a.m. - 5:00 p.m.	Field trip (take sack lunches)
6:00 p.m.	Dinner
7:00 - 7:30 p.m.	Microhabitat observation
7:30 p.m.	Set live traps for mammals
8:30 p.m.	Natural history charades

Thursday

6:00 - 7:00 a.m.	Optional nature hike; pick up live-trapped animals
7:00 a.m.	Breakfast

8:00 a.m. - Noon	Small group activities: 1. Teaching about mammals and their skeletons 2. Teaching about plants and trees
Noon	Lunch
1:00 - 2:00 p.m.	Stream flow activities
2:00 - 4:00 p.m.	Guest speakers to introduce "Project Learning Tree" and "Project Wild"
4:00 - 5:30 p.m.	Natural history writing
5:30 - 6:30 p.m.	Microhabitats wrap-up
6:30 p.m.	Dinner
7:30 - 9:30 p.m.	Insect identification

Friday

7:00 a.m.	Breakfast
8:15 - 9:30 a.m.	*Natural Inquirer* writing and final submissions
9:30 - 10:30 a.m.	More about specimen collections
10:30 a.m. - Noon	Next steps for using your own local natural resources to teach science
Noon	Lunch
1:30 - 2:30 p.m.	Post-test, evaluation, and good-byes

Our current list includes:

- How to conduct a natural history field school
- Bird feeders and bird houses
- Crystals: An activity handbook for teachers
- Dinosaur information package
- Earth science handbook of activities for teachers
- Habitats activities
- Rock and mineral identification
- Teachers' guide to insect activities
- U.S.D.A. activities for learning about conservation of forest resources
- Water activities
- Handbook for mountain life zones exhibit

Helping teachers design a nature trail at their school. Among the more intensive follow-up support activities undertaken by NMRSEP staff is assistance with the development of a school nature trail. A nature trail can be a small path near the school or a large outdoor classroom. Even an area that seems devoid of natural resources may be deceiving. Is there an ant hill? Many different activities can be done centering on ants. Are there examples of erosion? What about plants? Even weeds can be useful teaching tools. The principal task in developing a nature trail is to identify areas or features along the trail that can be used as learning stations for participating science activities. If the trail is long, a map describing the route should be made. Approximate distances and compass settings can help teachers navigate from one station to the next. Teachers may want to plant trees or wildflowers or plants that attract particular kinds of wildlife. Their local forester or soil conservationist can help them further with this. Large samples of different rocks from the area can be placed along the trail.

NMRSEP staff helped teachers at Cuba Elementary School develop their nature trail and create an extensively documented trail guide. Stops along the Cuba nature trail have fun names, including names with Navajo or Spanish words:

Station 1: Give Ants a Chance
Station 2: Flores Silvéstres (Wildflowers)
Station 3: Wosh (Cactus) - A Prickly Subject
Station 4: Madera Vieja y Madera Nueva (Old wood and new wood)
Station 5: Rock and Roll!
Station 6: Mi Casa (My House)
Station 7: You Like'Em, I Lichen!
Station 8: Trees, if You Please!
Station 9: Eh Holé (A Test)
Station 10: The Gall!
Station 11: Don't Take It for Granite!
Station 12: "Scratch And Sniff" Sage
Station 13: Rain, Ice, Wind, and People!

Station 14:	North Vs. South!
Station 15:	Back To the Future!
Station 16:	Hug A Tree!
Station 17:	Ya Ta Hey! (Hello)

9. ADDRESSING ETHICAL, CULTURAL, AND EQUITY CONCERNS

At NMRSEP we believe that, in working with schools, it is our responsibility not only to convey the principles of science and good teaching, but to model and provide information about ethics in scientific inquiry. We also recognize the importance of engaging *all* students in learning, and of respecting the great variety in cultural traditions and values.

Ethical concerns

Scientific knowledge has innumerable applications. Many of them, from the use of nuclear energy to the testing of cosmetic products to the dissection of frogs in junior high school classrooms, are a source of ethical debate. It is not your job to impose your personal values or ethical beliefs on the teachers with whom you work, just as it is not the teacher's job to impose her or his personal values on students. However, you *can* stress to teachers their responsibility for recognizing the different perspectives that exist regarding a great range of scientific applications. You can emphasize the importance of learning as much concrete information as possible about a given issue or application, weighing the evidence, and drawing one's own conclusions about whether the benefits outweigh the costs. And you can encourage teachers to instill in their students the habit of open-minded inquiry and investigation.

Conservation ethics. One thing you should actively encourage in your work with teachers and students is the importance of conservation ethics, given the critical environmental problems confronting our planet. The books, *50 Simple Things You Can Do to Save the Earth* and *50 Simple Things Kids Can Do to Save the Earth* (Earthworks Press, Berkeley, CA), will give teachers a good start in learning about conservation ethics. Urge teachers to set a good example and to relate ethics to children by having them "pack it in, pack it out" on field trips and at field schools, teaching them other ways to conserve energy and materials in their daily lives, discussing conservation issues, and presenting learning activities focused on the environmental impact of various influences.

Collecting ethics. As discussed in chapter 7, there are numerous laws governing the collecting of fossils, plants, and animal remains. The importance of learning about and obeying these laws cannot be overemphasized. In addition to collecting laws, however, there are collecting ethics that need to be considered even when all laws have been addressed. Stress to teachers the following guidelines:

- Never collect more specimens of any kind than are actually needed by your class for a lesson.
- Limit your collecting activity to the specific areas in which you have permission to collect.
- Be respectful of the property on which you are collecting.

- Never collect archaeological materials or artifacts. *Please remember the difference between a paleontological and an archaeological specimen. Archaeological specimens are any remains that indicate human activity: potsherds, arrow heads, etc. There are potent federal and state laws protecting collection of artifacts on any type of land.*

- Do not collect any *vertebrate fossil* that you may find; instead, note its location and report it to the museum. Remember that the value of a fossil is drastically reduced when it is removed from its original location.

- If you are collecting fossils, please take the time to look at *all* the fossil specimens collected. There is always a "chance in a million" that a student will find something that should be brought to the attention of museum staff. If such a fossil is found, please stress the possible scientific importance of fossils and their potential usefulness to a museum or university.

Cultural traditions and norms

Cultural values can affect students' and teachers' attitudes about and willingness to participate in science education activities. It is important to learn about cultural norms and traditions among the populations with whom you work and to identify those that relate to science teaching. In New Mexico, for example, many Native American cultural norms conflict with learning in the public educational system. Avoiding the use of specimen remains from prohibited animals, bones, feathers, and snakeskins, and demonstrating respect for traditional beliefs in sacred animals such as bears, can facilitate science learning among Native American students. Doing some background research and checking with school and community members will help you discover any potential problems related to the use of specimens and scientific teaching techniques.

You can also take advantage of the opportunity to highlight, in a positive way, the value to our country of having a mix of cultural traditions and perspectives. You can discuss approaches to scientific inquiry and the use of scientific knowledge among different cultures. Teachers can present learning activities that draw on cultural traditions; for example, a teacher from the Los Lunas, New Mexico, School District has developed an activity focused on the use of medicinal herbs in traditional Hispanic households.

Assuring access for persons with disabilities

Students with disabilities -- whether physical mobility, hearing or visual impairment, or developmental delays -- should be able to participate fully in the kinds of hands-on science activities described here. In fact, NMRSEP's focus on integrated, multisensory teaching techniques is a critical element in special education. You can offer suggestions and guidelines to teachers, reminding them that a little extra effort can result in access to the world of science for students with disabilities. Here are a few suggestions:

- For students with mobility impairments, select field trip or field school sites that offer handicapped access. (Many National Forest lands and parks provide wheelchair access on designated trails.) Field trips need not always be away from the school; a playground surrounded with plants or bounded by a field, or a nearby pond with a level access path can provide hours of teaching time.
- For students with visual impairments, use activities involving auditory, tactile, and kinesthetic learning. Many activities can easily be adapted -- for example, for the "Timeline" activity described in chapter 6, students could use touch rather than sight to determine the appropriate placement of items on the timeline. Take advantage of the often enhanced hearing abilities of students with visual impairments by asking them to note what they hear on field trips or nature trails.
- For students with hearing impairments, use activities involving visual, tactile, and kinesthetic learning. Again, many activities need only slight adaptation to include all students.
- For students with developmental delays, emphasize concrete learning.
- If your school develops a nature trail, make sure it offers access to students with mobility impairments. Include braille notations on station signs; provide braille or audiotaped versions of trail guides.

Taking positive steps to overcome stereotypes

The statistics concerning today's students and their interest and achievement in science are discouraging in general; however, they are most discouraging in terms of the numbers of female and minority students who pursue science studies. A major reason for low science enrollments and achievement among female, African American, Hispanic, and Native American students is racial and gender stereotyping. Stereotypes can be conveyed in subtle as well as overt ways -- through the illustrations in textbooks, through the number of times a teacher calls on a student or praises the student's answer, through the often unconscious assumptions many of us make about who will be afraid of handling a frog or reluctant to get their hands muddy.

It is important to make positive efforts to counteract such stereotyping. Through your program, you can offer teachers both models and information to help them break down their own stereotypes and encourage all of their students to participate fully in science activities. You can provide information about scientists like George Washington Carver (agricultural scientist), Jose Delgado (a Yale researcher who studied the effects of electrical stimulation on the brain), and Marie Curie (the only person in history to win two Nobel prizes, for physics and chemistry). You can encourage teachers to invite women and minority speakers to their classrooms, and help them to identify such speakers. Ask teachers to observe their own behaviors (or, if they are willing, each others') in selecting teams, calling on students, and praising or encouraging students during science activities, to identify any stereotypical patterns. Encourage them to assure an equal mix of children in small group or team activities, and to be equitable in selecting individual students for special duties.

An excellent strategy for reducing stereotypes, building students' self-esteem, and improving relationships among students of different racial, ethnic, or cultural backgrounds is *cooperative learning*. Cooperative learning is an instructional strategy in which small groups of students work together to meet common learning goals. Student groups are heterogeneous not only in terms of students' ethnicity or gender, but also in terms of students' performance levels. The learning task presented to the group requires the active participation and interaction of every student in the group; the task cannot be completed successfully if only one or a few students do the work of the entire group. Moreover, every member of the group has an equal opportunity to succeed at the task, whether they are high, average, or low achievers. Cooperative learning has resulted in higher achievement levels among students at all grade levels; it is particularly effective in strengthening students' thinking skills.

Using cooperative learning techniques is not a complicated process once you have grasped all its principles, but it requires that you (or the teacher) follow some rather specific guidelines. There are a number of considerations to address, from identifying cooperative tasks to determining the appropriate group size to assigning students to groups. However, it is well worth the effort to investigate and master this instructional strategy. The following sources offer helpful background information or learning activity ideas that can be adapted for science studies:

Circles of Learning: Cooperation in the Classroom (1986)
D.W. Johnson, R.T. Johnson, and E.J. Holubec
Interaction Book Company
7208 Cornelia Drive
Edina, MN 55435
(612) 831-9500

Cooperative Learning: Resources for Teachers (Revised,1987)
Stewart Kagan
Resources for Teachers
27134 Paseo Espada #202
San Juan Capistrano, CA 92675
(714) 248-7757

Cooperative Learning: Student Teams (1987)
Robert E. Slavin
National Education Association
1201 16th Street, N.W.
Washington, DC 20036

Team Up: Activities for Cooperative Learning, 5-6 (1990)
National Education Service
1821 West Third Street, Suite 201
P.O. Box 8
Bloomington, IN 47402

10. EVALUATING YOUR PROGRAM

On-going evaluations of your efforts are necessary for several reasons, but the primary one is improvement. For individual activities (a workshop, a field school, an intensive summer institute) as well as for general checks on progress (an initial profile of teachers, an end-of-year program review, a student assessment of growth in science skills), evaluative information about the program can help you adjust your approaches and improve your effectiveness. Such on-going evaluation can help you determine not only whether the school's objectives are being met, but also whether your museum's objectives are being met through your outreach program.

From this vantage, evaluation needs to be viewed in relation to both needs-sensing and planning. Needs-sensing provides the context for the work to be done; in this case, by giving information about the status of science teaching at the schools you are working with (see chapter 4). Planning, when it is informed by needs-sensing, leads to the development of a program that addresses identified needs within the constraints of both the school and the museum. Once the program is implemented, evaluation then provides information about its operation and effects, information that can be fed back into planning (along with additional needs-sensing) to make program improvements.

Needs-sensing and planning

As mentioned earlier, a needs-sensing survey is helpful at the beginning of a project. First, it can help you gather information about the status of science teaching at a school site -- e.g., the attitudes teachers have about science teaching, the amount of time they spend teaching science, the resources they employ, and the obstacles they perceive. Second, discussing the results of your survey can help you build trust within the school. If teachers see you asking for information about their needs, see you openly discuss what was learned, and help you plan a program that addresses their identified needs, then the program you implement will have a greater legitimacy in their eyes. Teachers will have a much greater sense of ownership in the implemented program, and this will help its success.

Needs-sensing does not have to be a static activity, conducted once at the beginning of an effort and never more. Needs-sensing can be on-going, using both formal methods (e.g., survey instruments, focus groups) and informal methods (observation, discussion with individual participants). Indeed, needs-sensing is best used as an on-going activity, for once your program is implemented, you will likely encounter obstacles that could not be anticipated in planning the program. A good needs-sensing effort will identify these difficulties, and the information gathered can be used in making program modifications.

Just as needs-sensing should be on-going, so should planning. You will find it helpful to bring participants together at key junctures in the program (e.g., end of a year's worth of activities, beginning of a new program year) to review what has gone right and what has gone wrong. If such information is freely shared in an atmosphere of collegiality, it can be used to collaboratively plan for program modifications. Again, the more collaboration involved in planning, the greater the likelihood of success in implementation.

Evaluation

There are a number of ways to look at evaluation of your outreach efforts. For the purposes of this manual, we have identified the following three:

- event evaluations, which focus on isolated program components (such as workshops, field schools, and summer institutes) and their effects on participants,
- impact evaluations, which focus on outcomes for students who have been taught by teachers participating in your program (thus, an indirect effect of your program), and
- program evaluations, which look at the overall set of services being provided to the school.

Event evaluations. We recommend that you plan and produce individual events with evaluation in mind. Share objectives and goals with teachers in advance of their participation. Whenever possible, contact a sample of participating teachers in advance, seeking information about the specific needs and objectives of those who will attend. You can use this information to shape presentations and activities, avoiding what is the downfall of many such activities -- irrelevance to the target audience. We also suggest that you give post-event evaluation forms to all participants, asking about:

- how well the event addressed its stated objectives and the needs of participants,
- how useful the materials presented seemed to be,
- what changes in format, presentation style, or content would improve the event,
- what benefit the participants might have gotten from the event, and
- what follow-up would be useful to further strengthen their classroom work.

In some instances, you may want to design and administer pre- and post-tests focused on the content of the event. These can be useful in determining whether teachers have learned the specific information presented.

After the event is over, you may want to hold a debriefing session. Museum staff and volunteers, a few key participants, your school contact person, and any key school administrators who have been involved in the program can discuss the event and note changes needed to improve future efforts or follow-ups that might strengthen the intended results. You may also want to contact a sample of participating teachers several weeks or months after the event to assess its long-term usefulness.

Impact evaluations. Most school administrators will want to know whether or not the programs they support are having any influence on the children they are charged to serve. Generally they will want to know whether students' attitudes toward science and/or test scores that reflect science skills are showing improvements. Most administrators will also realize that they cannot expect immediate gains; in many cases it can take several years for a program's effects to be reflected in student test scores, especially standardized test scores. However, the pressures that administrators are under will not allow them to wait indefinitely for results. Therefore, you will need a plan for addressing the issue of student outcomes.

As noted above, administrators will most likely be interested in student knowledge of science and student attitudes toward science. Associated with each of these are numerous indicators of attainment. For example, knowledge of science can be assessed through standardized test scores, school grades in science, quality of student science projects, and demonstration of science skills. Student attitudes toward science can be assessed through self-reports of attitudes, participation in science activities, and parental reports of student attitudes.

By convening a set of knowledgeable teachers and administrators, you can look at the options available to you and determine which of these indicators are both feasible and useful for the purposes of your program. For example, one strategy is to examine the standardized tests the district is using, identify items that reflect science knowledge (the test publisher should have such information available), and decide whether or not the content of your program addresses those test items. If it does, you can track student performance over time on the selected items as one indicator of student impact. If not, then other ways of assessing student science skills (e.g., through a customized instrument or through systematic observation) will need to be discussed. These types of assessment can become very technical, however, and you might seek consultation from a school district evaluation expert or from area university personnel.

Program evaluations. In program evaluation, you seek information about the effectiveness of the overall program as perceived by its various "stakeholders" -- those who have an interest in how the program is working (e.g., museum administrators and board members, school administrators and board members, teachers, students, parents, and other partners you might be working with). To accomplish this task, you will first need to generate a fairly complete description of the program: what activities have been provided, over what period of time, to what participants, and with what apparent success or lack of it. With such a description, you can generate questions about the key components of the program and seek information about how those components have been perceived by the various stakeholders (either through printed surveys, individual interviews, or focus group discussions). Next, you can summarize the views of the various stakeholders and make recommendations for program improvements based on those summaries. Finally, you can share this information with stakeholders and feed it into your planning process for subsequent work at the school.

Instrumentation

In carrying out these evaluations, do not be afraid to construct your own instruments. Keep in mind the focus of your evaluation effort (i.e., the specific program elements of interest) and draft questions that unambiguously seek information relevant to that focus

Of course, it is a good idea to let someone else (a colleague, a participating teacher, a school administrator) review your draft instrument to see if their perceptions of its clarity match yours!

In designing instruments you will be forced to consider whether to obtain quantitative and/or qualitative data. The advantages of quantitative data are that they can be easily summarized. For example, using a five-point scale, you can ask participants to rate how useful a certain activity was, and then compute an average rating to summarize the set of responses. Alternatively, you can ask an open-ended question (e.g., describe the most useful aspect of the activity) and then summarize the responses you receive with respect to a classification scheme that you have developed. In the latter case, the data will be much richer, but summarizing them will be more difficult.

To take a second example, you might ask participants how they generally present a given topic (qualitative data); alternatively, you can provide a list of the possible ways to present the topic (ways that interest you and your work with the school) and ask participants to indicate which ones they use (quantitative data). As a rule of thumb, quantitative approaches can be employed when you know in advance what response categories are appropriate; when you do not know these categories in advance, a qualitative approach will probably be more productive.

In closing, the most important thing to remember about evaluation is that it serves program improvement -- if you carry out evaluation simply to please a funding source, then it is not likely that the results of the evaluation will have any positive influence on the program. Indeed, such evaluation efforts can negatively influence the program if relevant information is collected and then ignored.

11. ADMINISTERING YOUR PROGRAM

Administrative concerns, while they may be the least exciting aspects of a program like NMRSEP, are critical to its success, not to mention its basic existence. Funding, institutional support, staffing logistics -- these can make or break any effort. The following suggestions may help you set up and manage your program.

Gaining your museum leadership's support for the project

The most important thing you can do to guarantee the success of your project is to make sure it has the active support of your museum's director and board of trustees. A rural science education program is a substantial undertaking that will necessitate adjustments in the schedule, organization, and resource allocations of the museum. In some instances it may require that staff adjust their attitudes about the museum's basic purposes and scope of operation. Without the wholehearted backing of the administration, the project can run into internal roadblocks that will make progress toward project goals difficult, if not impossible.

One way to gain leadership support for your project is to stress the ways in which it will contribute to the education and outreach missions of the museum. Most museums are finding that the justification for their existence, both in the public eye and that of major funding sources, is not in the role they perform as repositories of collections or exhibit halls, but in their function as educational institutions. For this reason, educational goals and objectives have moved to the center of most museum mission statements. The success of the museum in meeting educational goals and objectives is a strong selling point when seeking funding from major donors and grant sources.

A rural science education project can be a major showcase for the staff's talents and abilities and the museum's programs and collections. Through the extension of its outreach to previously underserved populations, the museum can demonstrate its commitment to science education and the communities served in a very visible way.

In addition to pointing out the ways in which the project can contribute to the museum's educational mission and enhance its position as a "fundable" institution, also stress that a rural science education project will increase the museum's attendance and outreach figures. While it is difficult to arrive at accurate projections of participants before the project is in place, you can obtain a general idea of minimum numbers in your preliminary discussions with rural school principals and teachers. As you determine the numbers of teachers and their class size, you can provide estimates of potential new audiences to be reached. Remember that you can count students as well as teachers in your impact estimates.

Paying for your program

Costs. The cost of your project will, of course, depend on the size of project you wish to establish, cost variations for your area, and the resources your institution is willing or able to contribute to the venture. If your museum has an adequate education and outreach staff you may be able to reassign some staff to work on the project rather than seeking funding to hire new staff.

Items to consider in your cost projections include: staff salaries and benefits, travel, publications and printing, supplies, equipment, and communications, which can include costs of mailings, telephone, fax, UPS, overnight express, etc. (A sample budget is presented on the following page.) When costing out your project, also be sure to determine the value of your museum's contributions to the project in terms of staff time, museum equipment, vehicle use, photocopying, secretarial services, supplies, and the like. These figures will be particularly important as you seek support from granting agencies.

Funding sources. No matter what the scale of your initial project, the major concern will be "Where is the money coming from?" Fortunately, you have several options.

Internal: This is a feasible alternative if your museum has sufficient staff and resources or has discretionary funds that can be allocated to new projects. If you start with a small scale project (with as little as a half-time person) that is funded internally, it will give you the opportunity to test the waters before deciding to commit museum funds and resources on a larger scale. It will also give your institution the opportunity to develop a successful track record, strengthening your appeal when you seek funding from foundations or other granting agencies.

Fees For Services: Another option to consider is that of marketing your project to schools on a fee-for-services basis. Possible alternatives may include offering an entire program package for a fee or charging fees for certain portions. Especially since you are working with resource-bound rural schools, you probably will not be able to support your entire program in this manner. But fees for services can be an important supplementary funding source and, again, can strengthen your appeal to other funders.

Partnership Arrangements: Another option for securing support for your program is a partnership arrangement with organizations or agencies that are willing to underwrite a part or all of the project. Examples of prospects for this type of cooperative venture include state agencies, state or local parks and recreation departments, the U.S. Department of Agriculture, county extension offices, the U.S.D.A. Forest Service, universities and colleges, local chapters of natural history groups, and groups such as the Sierra Club and Audubon Society.

Grants: Finally, you will want to seek funding from granting sources such as U.S. government agencies, foundations, and corporations. In addition to major funding sources like the National Science Foundation, the U.S. Department of Education, Title II funds, and the National Endowment for the Humanities, you can also approach local foundations, corporations with headquarters or major centers in your area or state, and area charitable organizations. Local chapters of the Kiwanis, Lions Clubs, Optimists, arts and humanities organizations, business and professional groups, and private citizens are active supporters of the educational and humanitarian activities in their com-

Suggested One-Year Budget*

	$$ Requested	In-Kind
Salaries		
Director/teacher trainer (1FTE)	$ 24,000	
Curriculum developer/teacher trainer (1FTE)	20,000	
Volunteer services (2000 hrs. @ $5/hr.)		$ 10,000
Benefits		
(25% of salaries -- may include FICA, workers compensation, unemployment, disability, retirement, insurance)	11,000	
Facilities Operation ($250/month/FTE)		6,000
Supplies and Materials		
General office copying ($50/month/FTE)	1,200	
Printing of 400 resource manuals, teacher handouts	4,000	
Resource materials (field guides, maps, specimens)	500	
General office and computer supplies ($50/month/FTE)	1,200	
Photographic materials and services	600	
Telephone, postage, fax charges, etc. ($100/month/FTE)	2,400	
Travel		
Trips to school sites (field surveys, workshops, follow-up visits -- 15,000 miles @ $ .26/mile)	3,900	
Per diem (80 person-days @ $60/day)	4,800	
TOTAL COSTS	$ 72,400	$ 16,000

*This budget is based on working with ten schools, making four trips per school, at an average of 375 miles each round trip.

munities. Many large corporations have active philanthropic programs in the regions where their business interests operate.

Do not restrict your search to donors who can fund your entire project. Smaller local donors can sometimes provide you with important pieces of equipment or materials, as well as funds for selected activities. A four-wheel drive vehicle, computer equipment, microscopes, or a plant press are all items essential for the project that could be donated by local philanthropic organizations, businesses, or individuals. Never underestimate your local sources of support. These are sources that, if you do your job well, can often be counted upon for repeat funding, continued interest, and sometimes volunteers.

If your museum does not have an in-house fundraising specialist or grantwriter, you may want to invest in a consultation with a freelancer. In addition, a useful guide to consult is *Securing Your Organization's Future: A Complete Guide to Fundraising Strategies*, by Michael Seltzer (the Foundation Center, 79 Fifth Avenue, New York 10003). You can also collect a wealth of information about local, state, and national foundations and corporations through the Foundation Center library in your region or state. (For the location of the nearest library, contact the Foundation Center at the above address.)

The following is a short list of potential funding sources:

Teacher Preparation and Enhancement
Materials Development, Research and Informal Science Education
Young Scholars Program
Contact: National Science Foundation
Washington, DC 20550
(202) 357-7076

National Program for Mathematics and Science Education
Contact: U.S. Department of Education
Office of Educational Research and Improvement
Washington, DC 20208

Planning and Implementation Grants
Contact: National Endowment for the Humanities
Washington, DC 20560
(202) 789-0284

Seed Money Grants and Traveling Exhibits
Contact: Association of Science-Technology Centers
1413 K Street, NW, 10th Floor
Washington, DC 20005
(202) 371-1171

Museum Assessment Programs (joint program with the Institute of Museum Services)
Contact: American Association of Museums
1225 Eye Street, NW
Washington, DC 20005
(202) 289-1818

General Operating Support Grants
Contact: Institute of Museum Services
1100 Pennsylvania Avenue, NW
Room 609
Washington, DC 20506

Placing the project organizationally

The placement of your program within your museum's structure will depend of course on the size and organization of the institution, but there would seem to be at least three logical options.

The first is placement within the Education Department. This has several advantages: already existing links with local schools, talents and expertise of the education staff, a support network, and an experienced cadre of volunteers. The mission of the project can easily be incorporated under the school services or outreach activities of this department. A second option is to include the project under museum outreach services. Your museum may already offer such outreach services as school programs, county services, and traveling programs.

A final option is the placement of the project in a museum satellite or outreach center in the area served. Satellite centers can be used as facilities for teacher education, creation and dissemination of materials, and planning and staging areas for field schools and institutes. Satellite facilities do not have to be owned or leased by the museum. Often libraries, farm extension offices, or federal agencies will open their doors to a science museum using their space for public education, especially if it involves teacher education or other program activities related to their functions.

Staffing

Staff salaries represent the biggest expense for almost any program, and your staffing options will be limited by the funds available. At a minimum, you could conceivably operate a modest program with a single, half-time staff person and a dedicated and skilled cadre of volunteers. An optimal approach is to have two full-time staff members and, again, a strong group of volunteers. If you are able to support two staff members, you then must decide whether the staff will work separately or as a team.

At NMRSEP, we prefer the team approach, with staff members working jointly to conduct field surveys, develop resource materials, and conduct teacher education activities and follow-up. Working as a team means that we can complement and draw on each other's strengths and skills, support each other through rough spots, offer constructive feedback and observations, and apply two creative and energetic selves to any given task. If one of us is ill, the other can carry on alone without affecting our level of service (usually with support from a volunteer).

The main disadvantage in working as a team is that you are able to serve fewer schools. As you decide how your program can best operate, consider whether your staff's skills lend themselves to a team approach (separate, complementary skills and experience) or to separate assignments (strongly similar skills and experience). Also consider whether you have sufficient volunteer support so that a single staff member will not have to venture out alone on field surveys, and so that volunteers can "cover" the schedule when the staff member is ill.

Project staff need to be people-oriented, flexible, and familiar with the workings of elementary schools. Essential qualifications include the following:

- prior science teaching experience,
- expertise in at least one branch of the sciences,
- strong interpersonal skills,
- proven ability to write and adapt educational materials,
- excellent oral communication skills,
- knowledge of effective instructional strategies and principles of child development, and
- respect for diverse cultures, values, and learning styles.

Another essential ingredient to staffing a rural science project is the support and close cooperation of your science and curatorial staff. If they are convinced of the significance of this program you will have vital help in the form of program design, consultation services, speakers, and demonstrations. You can remind them that your program can increase public support for curatorial and research activities, provide science staff with enjoyable experiences working with teachers and students, offer recognition for their special skills and areas of expertise, and enable them to contribute to training the scientists of the future.

Volunteers

Volunteers are an invaluable and essential resource for a program like NMRSEP. They have assisted us with planning, conducting, and following up on programs. They have conducted stations at field schools, assisted with activities at inservice workshops and the intensive summer institute, assisted in leading field trips during teacher inservice programs, and conducted field survey trips. On their own, and with the guidance of project staff, they have developed activities and written text on science topics and have constructed kits on science themes.

Lining up volunteers for your program. For NMRSEP, our main source of program volunteers is the museum's pool of docents and volunteers. As we work with volunteers on other museum activities, we can identify those with special interests or talents who can be integrated into NMRSEP. While many of our volunteers are, or were, school teachers, teaching experience is not a prerequisite. Among our regular NMRSEP volunteers are a U.S. Forest Service employee and a retired policeman.

In selecting volunteers, we look for certain qualities. Volunteers must be willing and able to travel and must enjoy working with both adults and children. They must be interested in the natural sciences; knowledge and experience in some particular area is desirable. In addition to expressing a keen interest in the natural sciences, many of our volunteers are also interested in astronomy, the physical sciences, and literature. NMRSEP capitalizes on volunteers' knowledge and experience by allowing them to conduct activities within their areas of expertise. Most volunteers who present portions of workshops for NMRSEP have had experience working as museum docents, school teachers, or Project Wild and Project Learning Tree facilitators, and have developed teaching and communication skills through these pursuits.

The New Mexico Museum of Natural History has a Volunteer Coordinator who recruits, interviews, and works with museum volunteers. Initial recruitment is done through advertising in Volunteer Association newsletters, free mentions in newspaper columns, volunteer sign-up sheets at fairs and shopping malls, and visits to schools, senior citizen centers, and volunteer organizations. Word of mouth also helps us; many volunteers contact the Museum directly.

New volunteers fill out a packet of information forms about their areas of interest and expertise, so that the Volunteer Coordinator can place them in a position to which they are suited. Also included in this packet are an Emergency Medical Form, a declaration form on which volunteers must declare all the natural history specimens they own, a compliance form attesting that they have read and will abide by the museum's Code of Ethics, and an application form for the NMMNH Association of Volunteers.

Volunteer training sessions are conducted both in a classroom format and in the exhibit halls to prepare volunteers to be hosts, exhibit hall interpreters, demonstration cart docents, tour leaders, and Naturalist Center docents. Periodic continuing education sessions are conducted by museum staff members to update volunteers on new material, new exhibits, or additions to existing halls. The duration of basic training for docents is eleven weeks. By the time volunteers are selected for NMRSEP they have had considerable training and experience in the natural and physical sciences, which, in addition to their own interests and areas of specialization, make them very valuable to the program.

How volunteers can help. Volunteers can assist with survey trips, preparation of manuals, field schools, summer institutes, inservice workshops, and preparation of follow-up materials.

Volunteers may complement the knowledge of staff as they conduct field survey trips. For example, a volunteer who is familiar with the birds of the state can assist in locating and identifying birds and their habitats. Also, volunteers who are familiar with the area to be surveyed can help by navigating back roads and pointing out special areas of interest. In writing manuals, volunteers with specialized knowledge are a great asset. Even a volunteer with no special qualifications in the subject area can provide assistance with research, writing, typing, and assembly of the manual.

Volunteers frequently take on "staff" roles in NMRSEP inservice programs, working directly with teachers and children. We use volunteers as assistants to help set up activities, as "back-ups" when a staff member is ill, as extra teachers when we have a particularly large group of teachers in our workshops, and as specialists to present information or activities in a particular area of expertise. We try to arrange for volunteers to attend our workshops as participants, so that they can learn the material and can lead the activities the next time.

Because of their importance to the program, the roles and responsibilities of volunteers should be well defined. Here are some tips for working with volunteers in inservice programs:

- It is important to be clear about who will be in charge of each part of the program. Prepare an agenda listing specific activities, leaders for each activity, and the time allotted to that activity.

- Problems should be discussed with the volunteer in private, away from the group or after the program. Because we are cautious in our selection of volunteers, we rarely encounter serious problems. However, if there is a problem that cannot be resolved, the volunteer is not asked to participate in another program.

- When a volunteer is leading a station or conducting a portion of the program, do not interfere with their work. Make it clear that you expect the same professional courtesy from them.

- Make sure volunteers understand that they should not be too technical in their presentations and should be careful to define any technical terms they use.

Examples of NMRSEP volunteer assistance at inservice workshops include the following: A volunteer, also a school teacher, discussed setting up a nature corner in the classroom as she had done in hers. Another volunteer, also a teacher, shared an activity on the special properties of minerals that she had developed. A retired police officer and science buff led sessions on nature photography and solar energy. (The solar energy activities, in particular, have been extremely popular with teachers.) This volunteer wrote out the activities on his home computer, and we edited them and included them in handouts to teachers. He also put together kits including inexpensive items such as plastic pop bottles, mirrors, and balloons, which the teachers could use to perform the activities for their classes. This same volunteer also conducted an evening star-gazing session with teachers and instructed them on how to construct their own telescope. He drew up plans for these, and we mailed them to teachers as a follow-up. A retired forest ranger discussed the trees of a region and performed pertinent activities with teachers at an inservice. These are only a few examples of the ways in which volunteers can assist in preparing, conducting, and following-up on inservice training.

Volunteers can assist with all aspects of field schools, including planning, implementation, and follow-up. They may assist in surveying the field school site and suggesting appropriate activities within their areas of expertise. They can participate in planning meetings, helping to determine what will be taught and by whom. They can develop new activities or adapt ones that have already been developed. Field school volunteers for NMRSEP have conducted activities focused on owls, ecology, seeds, soils, and tree rings, among others. Volunteer specialists from agencies like the U.S.D.A. Soil Conservation Service and the U.S. Forestry Service often enjoy conducting stations at field schools. Personnel from these agencies who have been facilitators for Project Wild or Project Learning Tree have valuable experience working with groups and can add much to your program. Persons without teaching experience of any kind may be a gamble, since they may not work well with groups of children despite their knowledge. It is a good idea to talk with them before you ask them to lead stations or give presentations, and get a feel for their abilities and experience. If you do not feel comfortable having them lead a station, you can team them with a museum staff member until they are ready to lead a station by themselves.

NMRSEP used volunteers extensively at our five-day summer teacher institute. Volunteer faculty included museum curators, educators, a mathematician and amateur astronomer from the University of New Mexico, a soil conservationist from the U.S.D.A. Soil Conservation Service, a wildlife biologist with the New Mexico Department of Game and Fish, and a forester with the U.S. Forest Service. These volunteers led discussions and activities on topics such as astronomy, soils, Project Wild and Project Learning Tree, nature art, bats, and many others.

Administrative concerns. In addition to collecting emergency medical information on volunteers and making sure that they understand and will abide by your museum's code of ethics and restrictions on collecting, there are several additional concerns to be addressed. First, your museum should decide on policies and procedures for reimbursing volunteers for expenses incurred while traveling for the program. For this information, you will need to consult the finance officer or business manager in your museum. Some museums do not allow reimbursements to volunteers. Ideally, however, funds should be allocated in the museum's budget to reimburse volunteers for mileage, gasoline, overnight lodging, and incidental expenses, such as photocopying and paper supplies. If reimbursement of volunteers is not an option, you may find that some volunteers are willing to forego reimbursement for meals. If staff are staying in a motel, their per diem may cover the motel room and the volunteers can stay in the room.

Liability is also a concern to be investigated thoroughly. Common museum practice is that volunteers are covered under the museum's general insurance or liability insurance policies when they are conducting activities on behalf of the museum, such as interpreting, participating in outreach programs, or driving museum vehicles. However, it is important to check with the museum's finance officer or business manager to make sure that this is the case in your institution and that a new outreach program will be covered. Some museums carry special insurance to make sure that their volunteers are covered.

Also check to determine whether volunteers are permitted to drive a museum vehicle. If so, do they require a special type of license? Some states require special licenses for certain types of vehicles. All of these issues should be discussed with your museum's director and finance officer when setting up your outreach program. Volunteers should be made aware of museum policies in their orientation sessions.

Your volunteer program will work most effectively if your volunteers feel they will benefit from participating in your program. Explain that, through the program, they will have the opportunity to meet interesting people and to visit and learn about new places in their state. We encourage our volunteers to enjoy themselves while on and off duty, and because we allow for free time, all of our volunteers have opportunities to explore for themselves and learn at the same time. The result is an enjoyable and rewarding activity for them, and invaluable support for our program.

12. CONCLUSION: CUBA: A SUCCESS STORY

We at NMRSEP have found our project well worth the substantial effort required to make it work. NMRSEP is a challenge and a pleasure for us and a rich resource for schools. Among our most notable success stories is that of Cuba Elementary School.

Nestled in the Nacimiento Mountains, an hour-and-a-half northwest of Albuquerque, is the village of Cuba, New Mexico. Cuba lies at an elevation of 7000+ feet, making the area cooler and wetter than average for New Mexico. The area's potential for teaching science is almost unlimited; within walking distance of the school, or right on the school grounds, are fields, terribly eroded areas, and opportunities for the study of geology, paleontology, botany, zoology, and ecology. The area has a wide range of trees, shrubs, and other plants, including pine, oak, fir, juniper, and sagebrush, to name only a few. Elk and deer often roam through the school yard. The geology of the area features fault zones, reversed sequences of rock layers, a copper mine, many of the major rock formations in the state, hot springs, petrified wood, and marine and terrestrial fossils.

Cuba was one of the original five pilot schools involved with NMRSEP. During the first year of the project, Cuba teachers produced learning "kits" focusing on a local natural resource. They also received extensive training and support from NMRSEP staff, who helped guide the development of their kits. At the end of the school year, NMRSEP staff were invited to an annual end-of-the-year picnic held by Cuba's elementary school teachers. NMRSEP staff decided to take along some microscopes, bones, and other natural history items. Much to the surprise of both teachers and staff, many children spent more time satisfying their curiosity with the objects brought from the museum than they spent playing games. From this revelation arose the concept of the natural history "field school." NMRSEP staff, working with Cuba teachers, organized and held pilot field schools in Cuba in the fall of 1987; an indoor field school was held in February, 1988.

Teachers who participated in the field schools at Cuba and other sites as chaperones and organizers felt they could learn from a similar school for adults. Their request led to the development of NMRSEP's Summer Elementary Science Teachers' Institute. Because of its abundant resources, Cuba was the location chosen for the SESTI program.

NMRSEP's third year of involvement with Cuba focused primarily on the development of a nature trail. Cuba Elementary School is fortunate enough to be located on 280 acres of land. Cuba teachers had been thinking about developing a nature trail since the school opened 16 years earlier. Due to lack of support, lack of interest, and lack of resources, however, the idea had faded. NMRSEP was able to supply the support and technical expertise needed to carry through with the project; with the involvement of NMRSEP staff, teachers renewed their interest in the trail. One teacher in particular was a tremendous force in the development of the trail. She motivated other teachers, got NMRSEP staff excited about the trail, and assigned tasks to other teachers helping in development. As the trail was staked out, teachers were asked to develop activities for the variety of stations along the trail. Topics were assigned based upon teachers' interest; thus, a teacher interested in wildflowers developed many of the activities in the wildflower station. All activities completed were then sent to the museum where they were formatted and edited on a Macintosh computer.

Museum staff added supporting information and illustrations to fill any gaps in the activities. This information was put into a loose-leaf notebook which can be added to or subtracted from as school personnel desire.

An unused building at the end of the Cuba nature trail was developed into a miniature resource and naturalist center called "Ya Ta Hey." Whereas the room had been filled with odds and ends and discarded books, it is now used to house plant specimens, minerals, fossils, books, maps, posters, activities, and artwork done by students. Thanks to the nature trail, the Cuba community has become involved in their elementary school. Shop classes at the high school made signs for the trail; a local copper miner donated geology specimens; and a local welder constructed gates for the doors of Ya Ta Hey. Since the trail has been in development, middle and high school teachers have begun to use it.

The local copper miner, introduced to Cuba teachers by NMRSEP staff, has spoken to a number of classes, donated specimens to the school, and identified mineral specimens for them; each year, he takes museum personnel, teachers, and children on tours of the mine. A local forester did a presentation on tree rings at a field school and at SESTI. Students from Cuba Elementary School have donated natural history specimens to the museum, and many Cuba classes travel the 90 miles to Albuquerque yearly to visit the museum.

Is all this effort making a difference? Talking with Cuba teachers would lead one to believe so. Many Cuba teachers have set up science corners in their rooms with specimens and materials acquired through the project. Teachers report that they are less afraid to try new science activities in their classes than they were before their involvement with the project. They encourage students to bring specimens into their classes for identification and are not afraid to say "I don't know; let's find out." Students have become more enthusiastic about science; some would rather get out on the nature trail than go to recess. Others say, "We love your class, because we never do science," when in fact science is a major part of their curriculum -- it just isn't taught from the textbook!

One teacher reported an "at risk" student whose interest had never been easy to hold, who found a picture of rippled sand dunes in a magazine at home. The next day, he took the magazine to class, pointed to the picture, then pointed at a specimen of petrified ripples in mudstone (donated by the copper miner). He told the teacher, "Look, Mrs. Mac, this [the petrified ripple marks] isn't going to change but this [the sand dunes in the picture] will!" That student's excitement and the mental connections he made between past and present, sand and rock, are the simplest, and greatest, rewards of a program like NMRSEP.

APPENDIX A
A HISTORY AND DESCRIPTION OF THE NEW MEXICO RURAL SCIENCE EDUCATION PROJECT

The New Mexico Rural Science Education Project (NMRSEP) began in 1986 as a cooperative outreach program initiated by the New Mexico Museum of Natural History in Albuquerque, and the New Mexico Center for Rural Education at New Mexico State University in Las Cruces. The original project was funded by the National Science Foundation (grant number MDR 8550535) as a research and development program to identify effective approaches for working with rural elementary teachers; the project's principal investigators were Jeffry Gottfried from the Museum of Natural History and Don B. Croft from the Center for Rural Education.

Year One, 1986 -1987. NMRSEP's first year involved five pilot elementary school sites in rural New Mexico. Project activities focused on training and assisting teachers in the development of hands-on natural science kits. Kits were to include locally available natural history specimens, background material, scientific apparatus, and suggested activities. Teachers were provided with training focused on science concepts, information and field trips focused on local natural history, training in principles of instruction and curriculum development, and strategies for building kits. NMRSEP staff also developed sample kits to be used as models by teachers.

The intent of the first-year effort was for teachers to develop kits that could be used by other teachers as well as themselves. Although many teachers developed kits that they used productively in their own classrooms, few materials were polished enough for distribution throughout the district. Teachers found the information provided through the project's training activities and the task of developing the kits to be useful; however, they objected to the time, effort, and skills required to develop science activities in a polished form that others would read and use.

Year Two, 1987 - 1988. Based on the outcomes for year one, NMRSEP staff shifted their focus during the project's second year in an effort to address teachers' preferences and constraints. Year two of the project, then, primarily involved three activities: sponsorship of natural history field schools, provision of individual support services to teachers, and the conduct of a five-day, intensive Summer Elementary Science Teachers' Institute (SESTI).

At the field schools, NMRSEP staff demonstrated hands-on activities with students, allowing teachers to observe interactive teaching methods that drew on local natural resources. Field schools were generally held at a site near the school, typically a national forest or tribal campground; most lasted two days, with younger elementary students participating one day and older students the next. After the field schools, NMRSEP staff prepared packets of information and suggested follow-up activities for teachers to use in the classroom. Staff also conducted follow-up meetings with teachers, working with them to integrate learning activities with the school's established science curriculum. Field schools were successful at generating student interest in science studies, teaching science concepts, and modeling hands-on teaching strategies. However, they were very labor-intensive for museum staff and did not prove to be a practical method of providing instructional support for teachers.

The summer institute was held in June, 1988, for two teachers from each of 10 rural school districts. NMRSEP staff and six volunteer specialists acted as instructors. Teachers and staff participated in a wide variety of science activities and explored the natural resources of the Circle A Ranch in the Nacimiento Mountains just east of Cuba, New Mexico, and other nearby areas. Through these activities, teachers gained extensive hands-on experience in natural science field studies. Teachers from each district met periodically during the week in order to adapt activities and approaches to their home environments and resources.

Year Three, 1988 - 1989. NMRSEP's third year marked the end of National Science Foundation funding and the beginning of a one-year effort funded by the New Mexico Commission on Higher Education. This grant was provided to the New Mexico Center for Rural Education, with Center director Everett Edington as project director. Staff from the Museum of Natural History were responsible (via a subcontract arrangement) for carrying out the project's instructional and support activities, with Center staff responsible for evaluating project efforts.

NMRSEP's year three activities, a culmination of what had been learned during the first two years of development, most closely resemble the package of services recommended to other museums in this manual. During year three, NMRSEP worked with 10 rural school districts, each of which paid a fee to obtain project services. Each district sent two teachers to the summer institute. In addition, NMRSEP staff conducted a field survey and developed a resource manual for each area. Each district was provided with two full-day inservice workshops for up to 30 elementary school teachers from their district. Inservice sessions consisted of field trips, presentations on local natural history, and hands-on activities modeled for teachers by NMRSEP staff. Project staff also mailed follow-up materials to each participant and encouraged teachers to contact them for ongoing assistance and resource materials.

Year Four, 1989 - 1990. In 1989, the Southwest Educational Development Laboratory (SEDL), which had identified NMRSEP as a "promising practice" for improving science instruction in rural schools, received a contract from the Office of Educational Research and Improvement, U.S. Department of Education to conduct the "Strengthening Science in Rural, Small Schools" project. This project, a cooperative venture involving SEDL (Wesley A. Hoover, Project Director), the Museum of Natural History (Michael Judd, Project Director), and the Center for Rural Education (Nora N. Hutto and O.D. Hadfield, Project Directors), is designed to refine and "package" NMRSEP's approach to rural science outreach and to make it available nationally to museum and rural educators. Through this project, the Museum of Natural History and SEDL have worked jointly to produce this implementation manual for rural educators, and to conduct a series of three demonstration workshops for museum educators. SEDL and the Center for Rural Education have produced a guidebook for rural school administrators, focused on strategies for implementing a variety of science education partnerships. Finally, all three agencies have jointly sponsored and conducted a national dissemination conference for both museum and rural school staffs.

During this year, staff from the Museum of Natural History are continuing to provide NMRSEP services to rural school districts on a fee-for-services basis. Staff are now developing plans to expand NMRSEP activities for the 1990-91 school year.

APPENDIX B
BIBLIOGRAPHY OF RESOURCE MATERIALS

The following list of books includes the books mentioned in the text of this manual, plus additional references that may be helpful to museum staffs and/or to the teachers with whom you work. It is organized into the following general categories:

1. Background information on science topics
2. Sources for learning activities or student study
3. Other information resources

Materials that we feel will be of primary interest to museum staffs are marked with *. Materials we believe to be of primary interest to teachers or students are marked with +. Other materials should be of use to either audience.

Background information on science topics

* *Audubon Society Field Guide Series*, a Borzoi Book, Alfred A. Knopf, Inc., New York. All are comprehensive field guides on a wide range of topics. Photographs are in color.

* *Audubon Society Nature Guides*, a Borzoi Book, Alfred A. Knopf, Inc., New York. Each of the guides in this series is arranged by habitat, with each book describing the birds, reptiles, amphibians, insects, wildflowers, and more, of each zone. Volumes include: deserts, wetlands, Western forests, Atlantic and Gulf coasts, grasslands, Eastern forests, and Pacific coast. All are illustrated and photographed in color.

* *Barnes and Noble Thesaurus of Geology* (1982), by Alec Watt, Barnes and Noble Books, New York.

* *Desert Plants*, Volume 4, Numbers 1-4 (1982). Special issue: Biotic communities of the American Southwest -- United States and Mexico, David E. Brown, Editor, Boyce Thompson Southwestern Arboretum, P.O. Box AB, Superior, Arizona, 85273.

Earth and Life Through Time (1986), by Stephen Stanley, W. H. Freeman and Company, New York.

Eyewitness Books, Alfred A. Knopf, Inc., New York. This series of books contains hundreds of color photographs and illustrations. Books are filled with useful information presented in clear and interesting captions. Volumes include the following:

- *Bird* (1988), by David Burnie

  - *Butterfly and Moth* (1988), by Paul Whalley
  - *Dinosaur* (1989), by David Norman and Angela Milner
  - *Early Humans* (1989), by Nick Merriman
  - *Fish* (1990), by Steve Parker
  - *Fossils* (1990), by Paul D. Taylor
  - *Insects* (1990), by Lawrence Mound
  - *Plant* (1989), by David Burnie
  - *Pond and River* (1988), by Steve Parker
  - *Rocks and Minerals* (1988), by R.F. Symes
  - *Seashore* (1989), by Steve Parker
  - *Shell* (1989), by Alex Arthur
  - *Skeleton* (1988), by Steve Parker
  - *Tree* (1988), by David Burnie

+ *A Field Guide to the Dinosaurs* (1983), David Lambert and the Diagram Group, Avon, New York. A useful guide.

* *Field Guide to Tracks of North American Wildlife*, by Myron and Charles Chase, NASCO, Fort Atkinson, Wisconsin. This book presents dozens of tracks, all actual sizes, of North American mammals and birds.

* *The Fossil Book: A Record of Prehistoric Life* (Revised Edition, 1989), by Carroll Lane Fenton and Mildred Adams Fenton, revised and expanded by Patricia Vickers Rich, Thomas Hewitt Rich, and Mildred Adams Fenton, Doubleday and Company, Garden City, New York. The illustrations in this book are very useful.

* *Glossary of Geology* (1987), Third Edition, Robert J. Bates and Julia A. Jackson, Editors, American Geological Institute, Alexandria, Virginia. An excellent geologic dictionary.

Golden Field Guide Series, Western Publishing Company, Inc., Golden Press, Racine, Wisconsin. This series covers a variety of subjects, including birds, trees, rocks and minerals,

amphibians, reptiles, and more. All are illustrated in color and easy to use; pictures and text are all on the same page.

Golden Nature Guides, Golden Press, Inc., New York. This series is an excellent introductory guide to nature. Books in the series range from birds to zoology; all are in color and include distribution and occurrence maps.

* *The Illustrated Encyclopedia of Dinosaurs* (1985), by Dr. David Norman, Crescent Books, New York. This is an excellent, comprehensive book on dinosaurs.

* *An Instant Guide to...*, Bonanza Books, New York, Mike Lambert and Alan Pearson. These guides are well organized, compact identification books. The pages are coded with color bars across the top of the pages indexing the contents into logical sections for each subject. Color illustrations are included. Volumes in the series include:

    - *Edible Plants* (1989), by Pamela Forey and Cecilia Fitzsimons
    - *Fresh Water Birds* (1988), by Pamela Forey and Cecilia Fitzsimons
    - *Insects* (1987), by Pamela Forey and Cecilia Fitzsimons
    - *Mammals* (1986), by Pamela Forey and Cecilia Fitzsimons
    - *Owls and Birds of Prey* (1989), by Mike Lambert and Alan Pearson
    - *Reptiles and Amphibians* (1987), by Pamela Forey and Cecilia Fitzsimons
    - *Seashore Life* (1989), by Cecilia Fitzsimons

* *Mammalian Osteology* (1980), by B. Miles Gilbert, B. Miles Gilbert, Publisher, 709 Kearney, Laramie, Wyoming, 82070. This book depicts many skulls and other bones of animals in actual sizes for direct comparison with specimens.

* *Peterson Field Guide Series*, Houghton Mifflin Company, Boston. This series covers 26 topics, including a guide to the atmosphere, birds' nests, and more.

+ *Science for the Fun of It* (1988), Edited by Marvin Druger, National Science Teachers Association, 17452 Connecticut Avenue, N.W., Washington D.C., 20009. In this collection, teachers, parents, and students delve into informal science education.

* *Simon and Schuster Guide Book Series*, Simon and Schuster, New York. This series covers a range of topics, including plants and flowers, trees, rocks and minerals, shells, and more. All are illustrated and photographed in color.

Stokes Nature Guides, Little, Brown, and Company, Boston. This series includes guides on observing insects, nature in winter, and bird behavior. Behavior and life-cycles as well as characteristics are discussed. These nature guides can provide the basis for many natural science activities.

* *Vertebrate Paleontology and Evolution* (1988), by Robert L. Carroll, W.H. Freeman and Company, New York. This is the foremost book on vertebrate paleontology available.

Sources for learning activities or student study

+ *Audubon Adventures*, by Ada Graham and Frank Graham, National Audubon Society, 613 Riversville Road, Greenwich, Connecticut, 06831. This illustrated elementary school level newsletter contains interesting topics and activities. It is published bi-monthly.

Circles of Learning: Cooperation in the Classroom (1986), by D.W. Johnson, R.T. Johnson, and E.J. Holubec, Interaction Book Company, 7208 Cornelia Drive, Edina, Minnesota, 55435, (612) 831-9500. A useful book describing ways of using the instructional strategy of cooperative learning in the classroom.

Cooperative Learning: Resources for Teachers (Revised Edition, 1987), by Stewart Kagan, and *Cooperative Learning and Language Arts* (1989), by Jeanne M. Stone, Resources for Teachers, 27134 Paseo Espada, #202, San Juan Capistrano, California, 92675, (714) 248-7757. More useful books on cooperative learning, with many learning activities that can be adapted for science lessons.

Dinosaurs and Dinosaur National Monument, by Linda West, Dinosaur National Monument, Box 128, Jensen, Utah, 84035, (801) 789 - 2115. This resource packet for students and teachers has information specifically about Dinosaur National Monument, but also includes some useful activities and information about dinosaurs in general.

The Evolution Book (1986), and *The Science Book* (1979), by Sara Stern, Workman Publishing, New York. These guides contain a number of easy-to-do activities as well as useful background information.

+ *A Family of Dinosaurs* (1989), *Life After Dinosaurs* (1981), and *Where Are All the Dinosaurs* (1989), by Mary O'Neill, Troll Associates, 100 Corporate Drive, Mahwah, New Jersey, 07430. These three books are vividly illustrated and well written. Each book contains a complete glossary defining the terms used.

A Field Guide to the Atmosphere (1981), by Vincent J. Schaefer, Houghton Mifflin Company, New York. This guide contains background material on weather phenomena and an excellent chapter describing many weather experiments and activities that can be adapted to different localities.

+ *Nature Club* (1990), by Troll Associates, 100 Corporate Drive, Mahwah, New Jersey, 07430. This series for younger naturalists includes accurate color illustrations and interesting text. Volumes include:

- *Birds*, by Peter Jill
- *Insects*, by Althea
- *Ponds and Streams*, by John Stidworthy
- *Seashores*, by Joyce Pope
- *Trees and Leaves*, by Althea

Outdoor Areas as Learning Laboratories: CESI Sourcebook, compiled and edited by Alan J. McCormick, ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Ohio State University, College of Education, 1200 Chambers Road, Third Floor, Columbus, Ohio, 43212. This collection is an excellent source of information and activities on natural science subjects.

Outdoor Biology Instructional Strategies (OBIS) (1980), Delta Education, Inc., Box M, Nashua, New Hampshire, 03061-6012, (606) 889-8899. Includes 97 activities, organized into modules, for 10-15-year old students. A directory is available free of charge; an OBIS Sampler is available from the publisher for $6.80.

Project Learning Tree, American Forest Council, 1250 Connecticut Avenue, N.W., Washington, D.C., 20036. An environmental education program for teachers of students, kindergarten through grade 12, Project Learning Tree is an excellent source of interdisciplinary activities; the program also provides workshops and inservice programs for teachers. They have developed more than 175 activities in science, mathematics, language arts, social studies, the humanities, and other subjects.

Project Wild Elementary Activity Guide (1983), Project Wild, Salina Star Route, Boulder, Colorado, 80302. Project Wild is an environmental and conservation education program for teachers of students, kindergarten through grade 12. Instructional activities are designed for easy integration into school subject and skill areas. Project Wild also publishes a secondary activity guide and an aquatic activity guide.

Ranger Rick's Naturescope, National Wildlife Federation, 1400 Sixteenth Street, N.W., Washington, D.C., 20036-2266. An excellent source of natural science activities.

Science and Children, National Science Teachers Association, 17452 Connecticut Avenue, N.W., Washington, D.C., 20009. This is an excellent magazine for elementary school teachers.

Science Through Children's Literature: An Integrated Approach, by Carol M. Butzow and John W. Butzow, Teacher Ideas Press, Libraries Unlimited, Inc., P.O. Box 3988, Englewood, Colorado, 80155-3988. This book contains participatory science activity ideas that draw on descriptions of science topics contained in children's books. It includes a useful introductory discussion on the integration of science and language arts.

Team Up: Activities for Cooperative Learning, K-6 (1990), National Education Service, 1821 West Third Street, Suite 201, P.O. Box 8, Bloomington, Indiana, 47402. Yet another book of cooperative learning activities, many of which can be adapted to science activities.

+ *Tracks*, Christie Bleck, Editor, Michigan United Conservation Clubs, P.O. Box 30235, Lansing, Michigan, 48909. This elementary level newsletter, winner of the 1984 National Wildlife Federation Special Achievement Award, is available by subscription for individuals or for a school class. It covers a variety of interesting topics.

+ *The Young Naturalist* (1982), by Andrew Mitchell, EDC Publishing, 8141 East 44th Street, Tulsa, Oklahoma, 74145. This introduction to nature studies is colorfully illustrated, with excellent information and activities.

Other information resources

50 Simple Things You Can Do to Save the Earth (1989), and *50 Simple Things Kids Can Do to Save the Earth* (1989), Earthworks Press, Berkeley, California. Two excellent sources of information on simple ways of conserving the planet's resources.

* *The Complete Hypercard Handbook* (1988), by Danny Goodman, Bantam Press, New York. A useful guide if you plan to set up a cataloging system using the Macintosh utility Hypercard.

Country Teacher, National Rural Education Association, 230 Education, Colorado State University, Fort Collins, Colorado, 80523, (303) 491-7022. This bi-monthly journal focuses on subjects of interest to teachers from small, rural schools; it can provide useful perspectives on work in a rural school.

Journal of Rural and Small Schools, National Rural Development Institute, Western Washington University, Bellingham, Washington, 98225. This journal addresses a variety of issues related to rural education.

* *QED School Guides*, Quality Education Data, 1600 Broadway, 12th Floor, Denver, Colorado, 80202-4912. QED publishes a directory of schools and school districts for each of the 50 states that can be helpful in identifying and contacting rural schools; the directories include private as well as public schools.

The Rural Educator, National Rural Education Association, 230 Education, Colorado State University, Fort Collins, Colorado, 80523, (303) 491-7022. This journal addresses a variety of issues related to rural education.

* *Securing Your Organization's Future: A Complete Guide to Fundraising Strategies* (1987), by Michael Seltzer, the Foundation Center, 79 Fifth Avenue, New York, 10003. A thorough, excellent guide to a range of fundraising strategies.

* *Tricks of the Hypertalk Masters* (1989), and *Hypertalk Bible* (1989), by The Waite Group, Howard Sams Publishers, Indianapolis. More useful guides for using Hypercard.

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